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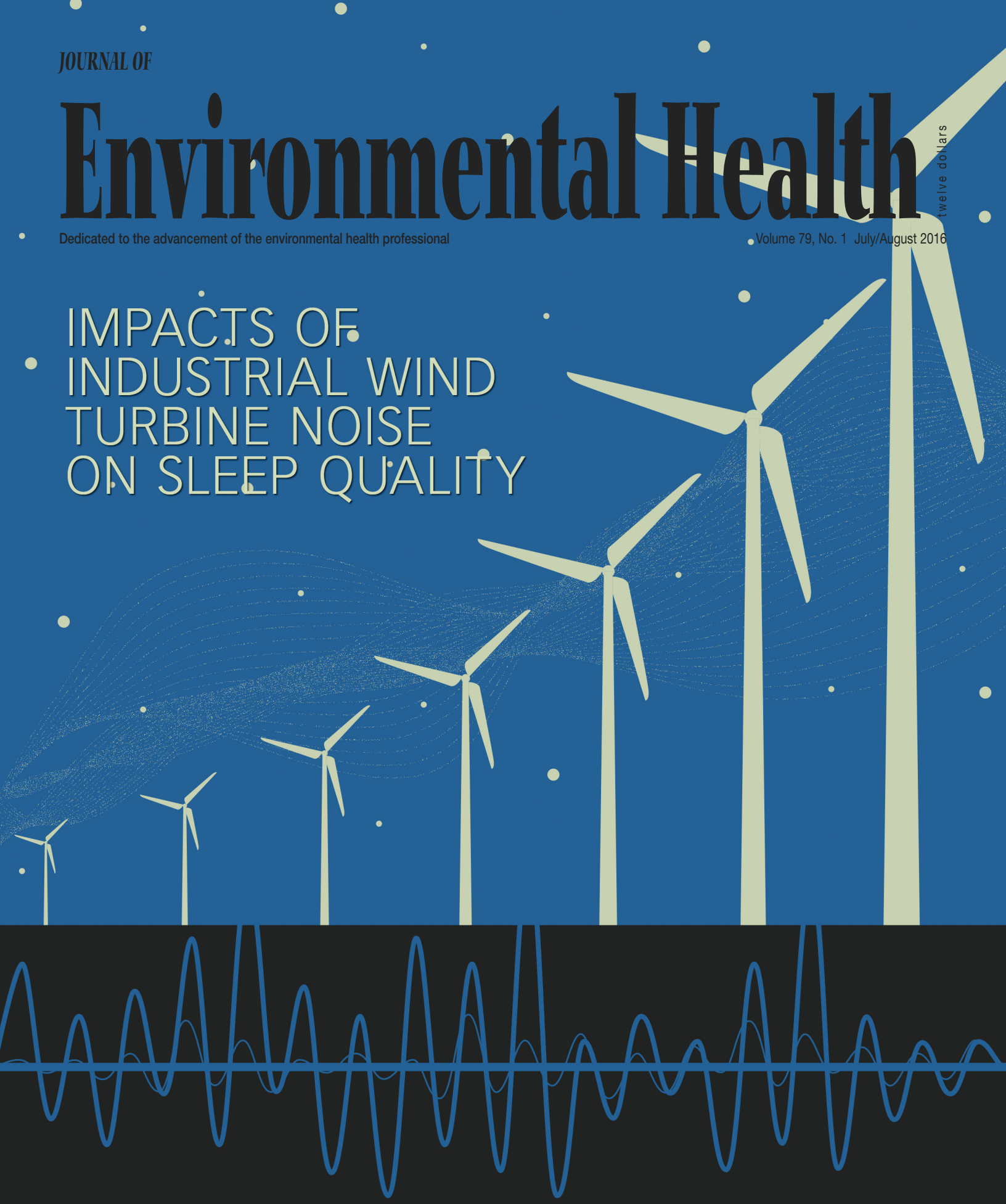

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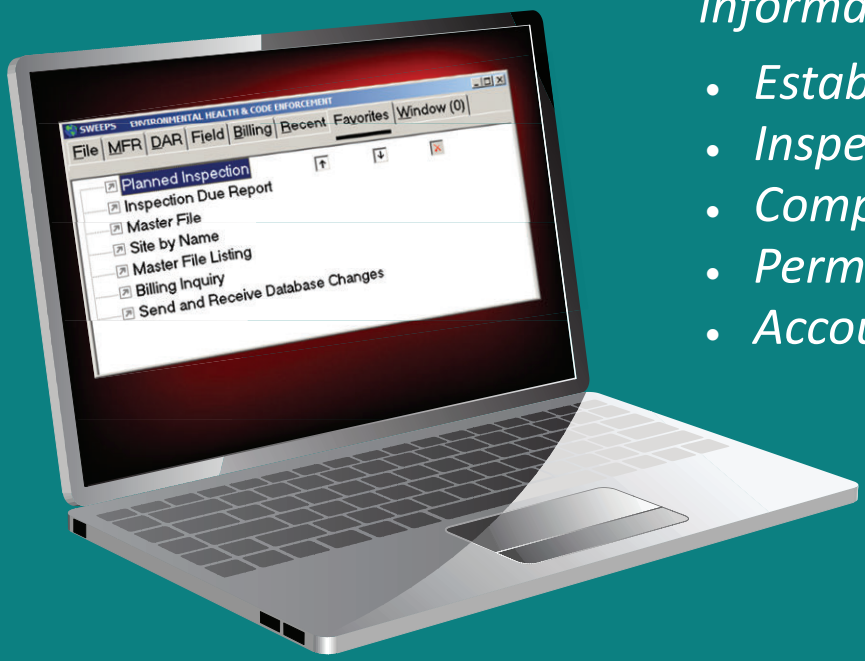

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ABOUT THE COVER

In this month's cover feature, "Impacts of Industrial Wind Turbine Noise on Sleep Quality: Results From a Field Study of Rural Residents in Ontario, Canada," the authors attempted to determine whether industrial wind turbines (IWTs) are a risk factor for poor sleep quality. A daily sleep diary and actigraphy-derived measures of sleep were obtained from participants in two rural communities, one with IWTs and a comparison one without IWTs. While the study results did not yield any statistically significant differences observed between the two study groups, it did highlight the strength of the combined use of actigraphy with sleep diaries to effectively triangulate an accurate view of sleep for use in future research.

See page 8.

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PRESIDENT'S MESSAGE

David E. Riggs,
MS, REHS/RS

Building a Better NEHA

As I drove home a few weeks ago from a meeting in Seattle, Washington, I listened to one of the presidential debates on National Public Radio. As I listened, it struck me that the speakers did not emphasize or stress any future goals and only discussed problems without any hint of solutions. Now as I am composing this column, my first President's Message, I have the duty, responsibility, and privilege to enumerate my goals for NEHA in the upcoming year.

This year will be very important in the evolution of our association. I say that because I believe this year will be like few others in the history of NEHA. We are growing, we are becoming more fiscally robust, we have expanded our professional capacity, we have broadened our resources, and we have increased our connectivity to local, state, and federal institutions and agencies. It is in this positive and dynamic operating environment that I share my goals for NEHA.

1. **Make NEHA inclusive of all the disciplines, practices, and professions that work in and contribute to the environmental health field.** Although we now have a Business and Industry Affiliate that is dedicated to our colleagues working in commercial operations, there are many more professionals working and contributing to environmental health that do not have a professional association to call "home." I have traveled around the country and have met many of these practitioners at seminars and trainings. There is a myriad of professionals seeking an association where they can learn, contribute, and grow. Occupations such as industrial and governmental environmental health and safety, hospital environmental services, and educational environmental services are but a few of the occupational areas that are seeking a suitable professional home. NEHA must become an inclusive association that promotes professionalism throughout all environmental endeavors.
2. **Make NEHA an active, vigorous, and dynamic association through the actions of its officers, board of directors, staff, and members.** As a profession we must continue to promote and implement high standards, and practice sound fiscal operation, connectivity, stakeholder involvement, and elevation of the profession and our reputation. During the last year, our board of directors and executive director have made great strides in restructuring our organization and expanding our presence and influence in Washington, DC, and with federal institutions, agencies, and officials. It is vital that expansion of our presence continues and that subsequent expansion of our credibility and influence flourishes.
3. **Make NEHA more attractive to younger, entry level, and mid-management environmental health professionals.** By 2018, it is estimated that approximately 50% of the baby boomers will be retired in all areas of the U.S. labor force. Of course, this estimate includes our profession as well. The millennial generation is the largest generation and is entering the national workforce at a rate of 17% per year. As the second largest generation, baby boomers are retiring at a rate of 18%–19% per year. Additionally, a great majority of national associations, as well as fraternal and charitable organizations, have been publicly concerned over flat or declining membership.

   For years we have voiced our mission to attract younger mid-management professionals, field specialists, and entry level professionals while sustaining our commitment to all environmental health practitioners. NEHA is actively instituting changes that will accomplish our mission. Changes to the format and structure of our Annual Educational Conference & Exhibition is just a beginning. Upgrading our Web site, increasing our use of social media, and digitalizing more of our content are but a few changes that are in process and will be expanded over the coming year. Establishing focus groups, surveys, and membership research will help us increase new membership recruitment and existing member retention.
4. **Continue our efforts to establish NEHA as the outstanding voice of environmental**

These goals will make us a stronger, more active association.

health and remain relevant to our practice and profession. Relevancy is arguably the most important goal that our association can accomplish this year, or in any future year. To be relevant to our members and their professions, ambitions, educational needs, reputations, and standards of practice is the heart and soul of NEHA. To be relevant to other associations and local, state, and federal agencies and elected officials is the path to a "seat at the table" and national influence for all our members. Relevancy is the basic foundation upon which we will continue to grow and expand into the premier voice of environmental health.

These goals will make us a stronger, more active association, and will enable us to be the voice of environmental health. In order to achieve any of these goals, it will take the efforts of the profession, association, and NEHA's membership, board of directors, national officers, and staff. I am confident that we are all up to the task.

David E. Riggs
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Did You Know?

NEHA offers a wide range of memberships to fit your professional needs. Individual memberships can be selected for one to three years, and you can select how you want to receive the *Journal* (either electronically or both electronically and in print). We also offer discounted membership rates for international professionals, retired professionals, students, and recent graduates. We have a sustaining membership for organizations, government agencies, and businesses. Finally, colleges and universities can join NEHA as educational members. Membership benefits may vary but one thing is true for all, you demonstrate your support for the advancement of the environmental health profession by joining NEHA. Please visit www.neha.org/membership-communities/join to learn more about our membership opportunities. And if you aren't a member, consider joining today!

INTERNATIONAL PERSPECTIVES

Impacts of Industrial Wind Turbine Noise on Sleep Quality: Results From a Field Study of Rural Residents in Ontario, Canada

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Abstract **The objectives of this study were to determine whether grid-connected industrial wind turbines (IWTs) are a risk factor for poor sleep quality, and if IWT noise is associated with sleep parameters in rural Ontarians. A daily sleep diary and actigraphy-derived measures of sleep were obtained from 12 participants from an IWT community and 10 participants from a comparison community with no wind power installations. The equivalent and maximum sound pressure levels within the bedroom were also assessed. No statistically significant differences were observed between IWT residents and non-IWT residents for any of the parameters measured in this study. Actigraphy and sleep diaries are feasible tools to understand the impact of IWTs on the quality of sleep for nearby residents. Further studies with larger sample sizes should be conducted to determine whether the lack of statistical significance observed here is a result of sample size, or reflects a true lack of association.**

Introduction

The current environmental situation has resulted in an expansion of renewable energy, including industrial wind turbines (IWTs). IWTs represent an emissions-free alternative that can help reduce air pollution and illness related to air quality (Clark et al., 2010). Maximizing the electricity production from IWTs has resulted in development that encroaches on residential land, and this practice has led to an increase in environmental noise (Pedersen & Waye, 2007). Environmental noise is a growing concern for public health, given the association between noise exposure and cardiovascular disease (Stansfeld & Crombie, 2011), annoyance (World Health Organization Regional Office for Europe, 2011), cognitive performance (Passchier-Vermeer & Passchier, 2000), and sleep disturbance (Basner, Müller, & Elmenhorst, 2011).

Expansion of IWT developments, particularly in rural Ontario communities, has prompted residents living in the vicinity to urge local health authorities to respond to the high number of complaints concerning sleep disturbance due to IWT noise. While IWT noise has been associated with annoyance (Pedersen & Waye, 2004) and decreased health-related quality of life (Shepherd, McBride, Welch, Dirks, & Hill, 2011), there is a lack of scientific evidence to support health-related claims from IWTs (Chief Medical Officer of Health, 2010). Presently, IWT facilities continue to be installed in Ontario, despite growing concerns over the potential impacts on sleep and health that have led to active social movements that oppose further expansion of wind power resources. To begin to address the lack of empirical research on the impact of IWT noise on sleep, we used actigraphy and sleep diaries in a preliminary study examining the sleep quality of individuals who reside in the vicinity of IWTs compared with a community without IWTs.

Methods

Study Sample

Two rural Ontario communities were purposefully selected as study sites: one community with IWTs and one without. The unexposed community was selected in an area that was similar in terrain and demographic characteristics and also housed a renewable energy facility: a grid-connected anaerobic digestion plant. The study protocol was reviewed and received ethics clearance through the Office of Research Ethics at the University of Waterloo.

A random sample of 50 residences in the exposed community and 56 residences in the unexposed community were selected for door-to-door recruitment. This process made contact with 54 individuals, 29 of whom were from the exposed group and 25 of whom were from the unexposed group. Of these, 15 indi-

TABLE **1**

Demographic Variables for Participants Who Completed the Study

Variable	Statistic	Exposed	Unexposed	*p*-Value
n		12	10	–
Sex	Female	5	7	.39[a]
	% Female	45	70	–
Age	Mean (*SD*)	60.4 (12.1)	41.4 (13.4)	.04[b]
Distance from source (m)	Mean (*SD*)	794.6 (263.1)	2,931.6 (1,015.6)	–

[a]Wilcoxon–Mann–Whitney test.
[b]Student's *t*-test using unequal variance.

viduals from the exposed group and 12 from the unexposed group agreed to participate, giving a response rate of 52% and 48%, respectively, and 50% overall. These 27 individuals were given a brief health assessment to check for exclusion criteria such as diagnosed or self-reported sleep disorders, symptoms suggestive of a sleep disorder (e.g., heavy snoring, leg jerk, gasping for breath), psychiatric disorders, cognitive impairment, use of medication known to alter sleep, and medical conditions that alter an individual's daily independence. Of the 27 participants, two were excluded from the exposed group (both due to use of sleep medication) and two were excluded from the unexposed group (one due to a diagnosis of sleep apnea, and one who was not of legal age for participation).

The remaining 23 participants (13 exposed, 10 unexposed; final participation rate 43%) were asked to give their written consent and were invited to participate in the full study. One participant from the exposed group was lost due to noncompliance and another completed only the sleep diary.

Sleep Assessment

Actigraphy

Actigraphy, using ActiGraph GT3X+ devices to detect body movements during sleep, was used to measure sleep parameters. The actigraphs were worn on the wrist of the nondominant arm and all procedures recommended by the manufacturer were followed. Actigraphy data were analysed using the Cole–Kripke scoring algorithm for actigraphy (Cole, Kripke, Gruen, Mullaney, & Gillin, 1992) available with ActiLife software version 5.11.

Sleep measures included sleep onset latency (SOL), wake after sleep onset (WASO), total sleep time (TST), time in bed (TIB), number of awakenings, and sleep efficiency (SE). SOL was defined according to the Cole–Kripke algorithm as the time to the start of the first complete minute scored as sleep (Cole et al., 1992). Number of awakenings was defined as the number of blocks of adjoining wake episodes. WASO was defined as the number of wake minutes after sleep onset. TST was defined as the total amount of time scored as sleep. TIB was defined as the time between first attempting sleep to the final awakening. Finally, SE was defined as the amount of time allocated to sleep that was actually spent sleeping, expressed as a percentage.

Sleep Diary

Sleep diaries were used to provide an additional source of sleep data and more detailed information on perceptions of the quality of sleep and the causes of awakenings. Adapted from the validated Pittsburgh Sleep Diary (Monk et al., 1994), sleep diaries were filled out each morning and captured the time the participant went to bed, fell asleep, and woke up. Additional sleep variables included the number of awakenings and a ranking of perceived sleep quality on a 6-point scale. A series of behavioral questions asked participants if they slept with the windows open, and if they used earplugs or other sleep aids.

Exposure Measurement

Sound level meters were used to obtain estimates of noise exposure for IWT and non-IWT groups. Casella CEL-633 type 1 sound level meters were placed inside the bedroom of one participant in each group for five nights to ascertain noise exposure for exposed and unexposed groups. Noise assessment was based on the World Health Organization's recommendation of an 8-hour equivalent A-weighted sound level (LA_{eq}) (Kim & Van Den Berg, 2010) along with LA_{max} for the investigation of sleep state changes. This study employed a time frame between 23:00 and 07:00 for the assessment of noise exposure, to match the usual sleep pattern of healthy adults (Öhrström, Björkman, & Rylander, 1990).

Sound level meters were placed with the microphone at an inclination of 45 degrees and at the approximate height of the participant's ear when lying in bed. Settings were selected to enable the devices to turn on and off automatically for each observation night beginning at 23:00 and ending at 07:00. Sound level meters were calibrated to 1 kHz at 114 dB before the first observation and following the final observation.

Statistical Analysis

Statistical analyses were performed using SAS version 9.2. Descriptive statistics, including means and standard deviations, were calculated for all parameters. Student's *t*-test and Wilcoxon–Mann–Whitney tests were used to compare mean WASO, SOL, TST, TIB, SE, sleep ratings, and number of awakenings between groups.

Results

All participants were non-Hispanic white, over the age of 18 years, and resided in the community where they were recruited. IWT noise-exposed group participants were older, on average, and there was no significant difference in number of men and women in the groups (Table 1). GPS coordinates obtained following recruitment showed that participants in the IWT noise-exposed group resided at a mean distance of 795 m from the nearest IWT and unexposed group participants resided a mean distance of 2,931 m from the anaerobic digestion facility (Table 1).

Results of the five-night sleep assessment using wrist actigraphy are shown in Table 2. There were no statistically significant differ-

TABLE **2**

Sleep Assessed by Actigraphy for Exposed (*n* = 12) and Unexposed (*n* = 10) Groups Averaged Over the Five Study Nights

Variable	Statistic	Exposed	Unexposed	Ratio	*p*-Value[a]
Sleep efficiency (%)	Mean (*SD*)	88.5 (5.4)	91.0 (4.1)	0.98	.17
	95% *CI*[b]	(84.5, 92.4)	(88.0, 94.1)		
Sleep onset latency (min)	Mean (*SD*)	6.8 (1.8)	7.3 (2.3)	0.93	.22
	95% *CI*	(4.3, 10.8)	(5.8, 9.2)		
Wake after sleep onset (min)	Mean (*SD*)	44.0 (1.7)	30.6 (1.9)	1.44	.16
	95% *CI*	(31.5, 61.5)	(20.5, 45.8)		
Total sleep time (min)	Mean (*SD*)	436.7 (53.6)	413.7 (47.7)	1.06	.34
	95% *CI*	(400.2, 473.3)	(381.5, 445.9)		
Time in bed (min)	Mean (*SD*)	493.6 (48.3)	453.4 (53.1)	1.09	.09
	95% *CI*	(461.1, 526.1)	(419.4, 487.4)		
Awakenings (#)	Mean (*SD*)	14.4 (1.5)	13.4 (1.5)	1.07	.73
	95% *CI*	(10.1, 18.7)	(8.8, 18.0)		

[a]Student's *t*-test using unequal variance.
[b]*CI* = confidence interval.

ences between groups across observed sleep variables adjusted for age differences. Mean SE was 88.5% in the exposed group and 91.0% among unexposed participants (p = .17). Exposed group participants recorded 44 minutes of WASO, compared with 31 minutes in the unexposed group (p = .16). Mean TST for both groups was above 7 hours, with 494 and 453 minutes of sleep recorded by the exposed and unexposed, respectively. TIB and TST showed the largest amount of variation between groups, at approximately 200 minutes, regardless of exposure and age.

Results of the daily sleep diary are shown in Table 3. Those in the exposed group retired to bed an hour earlier, on average, than those in the unexposed area (22:00 versus 23:06; p = .02). Similarly, those in the exposed group reported going to sleep an hour earlier than the unexposed group (22:19 versus 23:19; p = .03); however, there was no major difference in the time participants reported getting out of bed (06:42 versus 07:06; p = .25). There was no significant difference in the mean reported sleep rating between the exposed (3.4) and unexposed (3.3) groups (p = .67). "Use of bathroom," followed by "child or partner" were the most commonly reported sources of awakening for participants in the exposed group, while participants in the unexposed group listed "other" and "child or partner" as the most frequent causes of awakening. Unexposed participants described more events as "other" than did exposed group participants. The most frequent descriptions of other sources of awakening included "dogs barking," "discomfort," and "restlessness." No reference was made to IWTs or IWT noise as a source of awakening among any of the participants.

Although a greater frequency of poor sleep nights were reported in the exposed group (22 versus 11 per 100 person-nights), there was no significant difference in quality of sleep between the noise exposed and unexposed participants, adjusted for age (p = .28). There was no significant difference in the odds of poor sleep after adjustment for age (odds ratio [*OR*] = 2.34; [95% confidence interval (*CI*) 0.68, 8.05]; p = .18) or sex (*OR* = 1.80; [95% *CI* 0.55, 5.88]; p = .33); however, males in this study were at 3.4 times greater odds of experiencing a night of poor sleep compared to females (*OR* = 3.4; [95% *CI* 1.05, 10.99]; p = .04).

Discussion

In this study, we did not demonstrate a statistically significant relationship between IWTs and poor sleep. There are several potential reasons for this, including no true association exists; a true association exists, but our sample size was too small to detect it; and a true association exists, but it was masked by uncontrolled confounders. Therefore, sample size and control of confounding should be addressed in future studies. This study did demonstrate that the combined use of actigraphy with sleep diaries permitted an effective and triangulated view of sleep. Continued use of actigraphy and sleep diaries in future studies is encouraged to allow for comparisons that will build our understanding of the association between IWTs and sleep. In addition, noise measurements taken inside the bedroom provided an estimate of the noise that is perceived by the individual.

Results obtained from a five-day sleep assessment did not show a significant difference in the prevalence of poor sleep among participants who live in the vicinity of an IWT and a group of unexposed individuals living with no IWT installations. An assessment of the situation is that the impacts of IWT noise ex-

TABLE **3**

Sleep Assessed by Sleep Diary for Exposed (*n* = 12) and Unexposed (*n* = 10) Groups Averaged Over the Five Study Nights

Variable	Statistic	Exposed	Unexposed	*p*-Value[a]
Time into bed	Mean (*SD*)	22:00 (0.82)	23:06 (1.14)	.02
	95% *CI*[b]	(21:29, 22:35)	(22:17, 23:56)	
Time of sleep start	Mean (*SD*)	22:19 (0.85)	23:19 (1.1)	.03
	95% *CI*	(21:44, 22:53)	(22:32, 00:05)	
Time out of bed	Mean (*SD*)	06:42 (0.79)	07:06 (0.54)	.25
	95% *CI*	(06:10, 10:14)	(06:43, 07:43)	
Sleep rating (0–6)	Mean (*SD*)	3.38 (0.77)	3.24 (0.59)	.67
	95% *CI*	(2.86, 3.90)	(2.81, 3.67)	
Sources of Awakening		**# (%)**	**# (%)**	***p*-Value[c]**
Use of bathroom		53 (49.5)	16 (12.8)	.45
Child or partner		22 (20.6)	36 (28.8)	.26
Pain		17 (15.9)	4 (3.2)	.12
Other		8 (7.5)	45 (36)	< .01
I don't remember		7 (6.5)	24 (19.2)	.06

[a]Student's *t*-test using unequal variance.
[b]*CI* = confidence interval.
[c]Wilcoxon–Mann–Whitney test.

posure on sleep are small and difficult to resolve in comparison to the larger impacts on sleep, including stress, poor sleep hygiene, and age. This finding was observed anecdotally from participants who commented that they were unsure of the cause of changes to their sleep and also objectively through the finding that TST between the two groups was similar and consistent with the sleep of rural residents (Chang et al., 2012) and the Canadian population (Statistics Canada, 2016). As a result, detection of the signal from other fluctuations in sleep was more difficult than expected using traditional epidemiological methods and would benefit from the lessons learned in the sophisticated approaches used to study similar hazards, such as air pollution and electromagnetic fields.

Previous studies investigating the relationship between IWT noise and sleep have failed to find an association, using estimated sound pressure levels (Pedersen & Waye, 2004) and distance from the turbine (Nissenbaum, Aramini, & Hanning, 2012) as a proxy measure for noise. An explanation for the lack of difference in sleep could be that IWT noise at night is mediated by the resulting sense of annoyance the IWTs cause (Bakker et al., 2012). Sleep disturbance is then the result of stress from a change in the environment leading to annoyance, due to attitude and visual impact associated with living near IWTs (Knopper & Ollson, 2011). Public health research would benefit from a change to a model that incorporates measures of annoyance, including perceptions of IWTs and its visual impact on the landscape, helping to enrich data surrounding the physical effects of IWT noise. In addition, incorporating measures of stress, both subjective and objective, might provide useful insight to future study of sleep disturbance in relation to IWT noise.

As mentioned above, the limitations of the study include a modest sample size and subsequent low statistical power; the absence of effect size estimates during study design made the a priori determination of the required sample size difficult. Therefore, given the prevalence of poor sleep seen in this study, future investigations using similar methods should incorporate a sample size of at least 150 individuals to achieve a robust level of statistical power. In addition, low estimates of exposure were recorded as a result of calm winds, which limit the generalizability of the findings. A review of wind conditions, however, revealed that wind speeds observed were not different from the norm for the time period that noise exposure was surveyed.

As demonstrated here, population research investigating the impacts of environmental factors relies on adequate sample size, as well as accurate assessments of exposures and outcomes to detect associations. Although our response rate was acceptable and we had little attrition, it is increasingly difficult to enroll participants in such studies as there are many factors that can hinder participation. Contentious issues, such as this one, face additional barriers to participation, such as organized lobbying of communities against participation (Hill & Knott, 2010), a lack of trust in researchers from residents, and beliefs that research cannot provide a positive impact. Therefore, a critical role of

the research and public health communities is to effectively communicate the importance of representative and adequate participation. Although we did so in the enrollment portion of this study, additional communication on this topic will aid future investigations. Finally, a second consideration is the time at which recruitment is done, as we observed more response during nonworking hours.

Conclusion

The present study was, to the knowledge of the authors, the first study conducted on a Canadian population to incorporate objective sleep measures in the investigation of the impact of IWT noise on sleep. The strength of the combined use of actigraphy with sleep diaries permitted an effective and triangulated view of sleep. Continued use of actigraphy and sleep diaries in future studies is encouraged to allow for comparisons that will build our understanding of the association between IWTs and sleep. In addition, noise measurements taken inside the bedroom provided an estimate of the noise level that is perceived by the individual. Ultimately, the ability to determine whether IWTs pose a risk to sleep is dependent on participation from residents. Here, local public health authorities can assist researchers by encouraging the community to participate, and promoting how participation will provide evidence to inform decision making.

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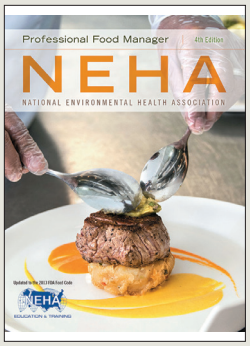

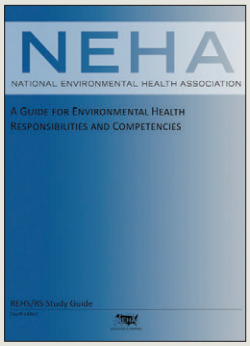

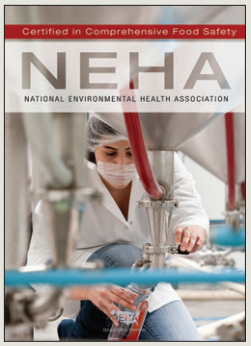

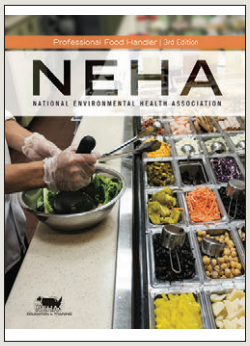

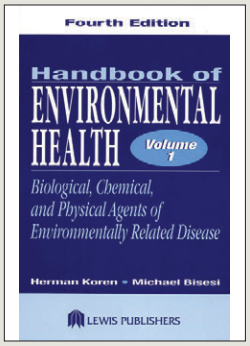

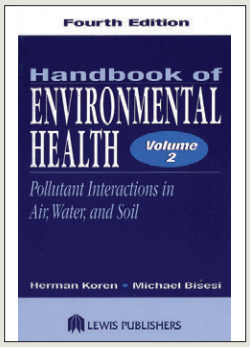

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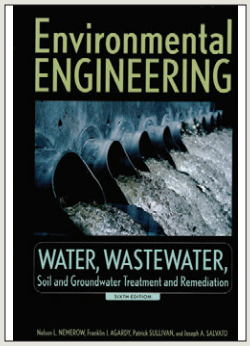

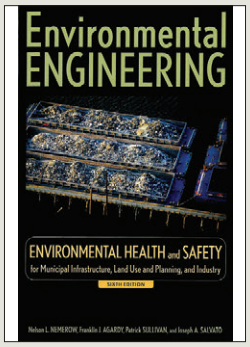

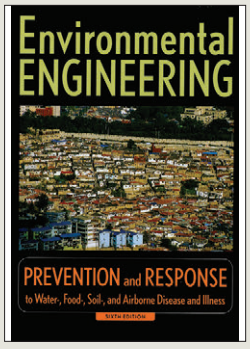

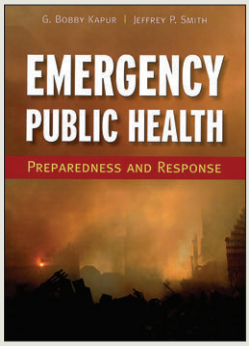

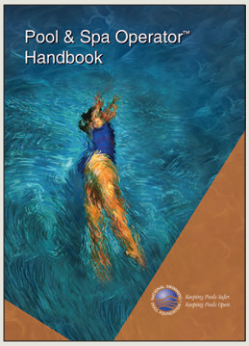

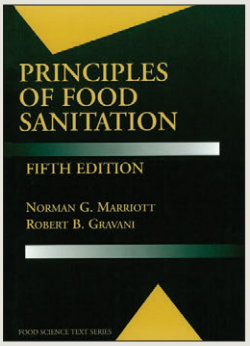

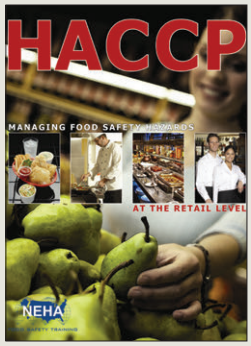

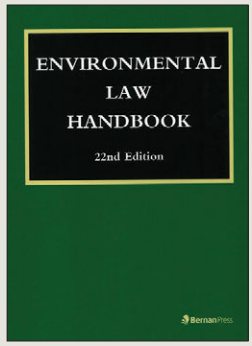

An Estimation of Potential Vector Control Effect of Gravid Mosquito Trapping in Fort Worth, Texas

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Abstract **Entomological surveillance is an essential component for integrated vector management (IVM), the current best practice for West Nile virus (WNV) prevention and control. The significance of vector mosquito surveillance, however, is not always recognized by the public, which increases vulnerability of IVM programs to elimination or downsizing when virus activities are low, particularly during interepidemics of WNV. In order to increase public recognition, the unrecognized contribution of mosquito surveillance with gravid (egg-carrying) mosquito trapping to WNV vector control was estimated using a novel approach. This approach includes development of a quantitative model to estimate the number of female progeny from a gravid mosquito and application of the model with mosquito surveillance data to estimate the potential vector control effect of gravid mosquito trapping. Applying this approach, the potential WNV vector control effect of 2013 surveillance activities in Fort Worth, Texas, was estimated to almost 1,590,000 female mosquitoes by capturing 44,654 females.**

Introduction

West Nile virus (WNV) first appeared in the United States in 1999 and since then has spread rapidly to the entire country. In Texas, the virus was first detected in 2002 and has become endemic, with occasional outbreaks and epidemics.

WNV is a public health concern in north central Texas, and local governments in the region play an essential role in WNV surveillance and response. Since the 2006 WNV outbreak, the number of human WNV cases has not been high enough to maintain public attention on WNV and accordingly, entomological WNV surveillance activities decreased until 2012, when the biggest WNV epidemic occurred in the region. During this interepidemic period, many entomological WNV surveillance programs in the region were eliminated or had limited activities due to an additive impact of low WNV activities and global economic hardship. The 2012 WNV epidemic, however, has increased public awareness on the unpredictable nature of WNV activities and enhanced public demand for a better and sustainable WNV monitoring and response system.

Integrated vector management (IVM) is the current best practice for WNV prevention and control, and entomological surveillance is an essential component of IVM. The surveillance provides real-time information on WNV activities for the public and also enables public health professionals to make a scientific judgment for appropriate public health intervention methods and the level necessary to control WNV.

Entomological surveillance in the southern U.S., including Texas, focuses on the southern house mosquito, *Culex quinquefasciatus* Say. This mosquito species is a primary vector for WNV in the Southwestern U.S. and the principal vector in Texas (Andreadis, 2012). This WNV vector is the predominant species in urban areas where the use of CDC Gravid Traps is more effective in vector mosquito sample collection compared with other sampling tools (Lee & Kokas, 2004; Reiter, Jakob, Francy, & Mullenix, 1986). This trap is designed to collect gravid *Cx.* mosquitoes, particularly mosquitoes in the *Cx. pipiens* complex, which includes *Cx. quinquefasciatus*. Testing gravid WNV vector mosquitoes offers a higher sensitivity to detect WNV than non-gravid vectors. In addition, capturing gravid WNV vector mosquitoes prohibits them from ovipositing eggs that could increase the vector population. This innate vector control effect of entomological surveillance activities, however, has not been recognized.

Thus, our study explored a way to quantify the underappreciated mosquito control effect of mosquito surveillance activities on the primary WNV vector and estimated potential WNV vector control effect of the 2013 entomological surveillance activities in Fort Worth, Texas.

Methods

Life table characteristics of *Cx. quinquefasciatus* in previous studies were used to generate a model to predict the female progeny size of a gravid female adult mosquito. We conducted a literature search for available peer-reviewed information in PubMed and tabulated the identified information for review and comparison. From the literature review, a three-factor model was constructed: the total

TABLE **1**

Life Table Characteristics of *Culex quinquefasciatus* and Experimental Conditions

Strain	Proportion of Eggs to Become Adult	Proportion of Female Offspring	Life Expectancy or Longevity of Females (Days)	Temperature (°C)/ Relative Humidity (%)	Blood Feeding Host/Availability	Source of Information
Average of five different strains of India	0.63	0.54	29.70	27.0 ± 1.0/ 75.0 ± 5.0	Chick/constantly available at night	Suman et al., 2011
Houston strain of USA	NA	NA	40.36	27.0 ± 10.0/ 77.5 ± 2.5	Mouse/every 2 days for 30 min during the daytime	Walter & Hacker, 1974
Vero Beach strain of USA	NA	NA	45.20	27.0 ± 1.0/ 77.5 ± 2.5		
Peshawar strain of Pakistan	NA	Assumed to be 0.50	74.13	22.8 ± 2.9/ 85.0 ± 7.0	Mouse/constantly available at night	Suleman & Reisen, 1979
Dar es Salaam strain of Tanzania	NA	NA	44.12	25.5 ± 1.5/NA	Mouse/every 3 days overnight	Kasule, 1986
Okinawa strain of Japan	0.80	0.43	64.4	25.0/75.0 ± 5.0	NA	Oda et al., 1999
	0.95	0.50	30.1	30.0/75.0 ± 5.0	NA	

Note: NA = not available.

number of eggs laid, the proportion of eggs to become adult stage (emergence), and the proportion of females in the newly emerged mosquito population. In selecting a value for each factor, experimental conditions of each study were examined for similarity to natural conditions, in particular, host availability during the natural feeding time of *Cx. quinquefasciatus* and rearing temperatures that are similar to ambient temperatures during the summer in the Dallas–Fort Worth Metroplex. In addition, a conservative or generally accepted value was chosen if multiple options were available.

The total number of eggs laid by a gravid female mosquito over its lifetime was estimated by the linear model that was derived from the published information (Suman et al., 2011). The linear model was generated in SAS version 9.3 and the equation of this model was used to estimate the total number of eggs produced by a gravid female *Cx. quinquefasciatus* with a particular longevity.

Mosquitoes were collected weekly in CDC Gravid Traps with grass infusion to monitor WNV activities in Fort Worth, Texas, in 2013. The data were collected from the beginning of May to the end of October. Each month the number of *Cx. quinquefasciatus* was counted and for comparison, monthly abundance of the mosquito population was described as the number of female *Cx. quinquefasciatus* per trap night.

To obtain a representative proportion of gravid female *Cx. quinquefasciatus* in the city, a total of 4,274 female mosquitoes was collected from July 2 through August 6, and individually observed for mature eggs in the abdomen under a stereo microscope.

Monthly longevity of the mosquito population was estimated with an assumption that mosquito population abundance in a particular month is determined by longevity of parental mosquito population in the previous month—the longer lifetime a female has, the more offspring she produces. We estimated the longevity of *Cx. quinquefasciatus* based on our literature review and used this for the expected lifetime of the parental mosquito population in the previous month (X - 1) of a particular month (X) when abundance of a mosquito population was highest. Expected lifetime of the parental mosquito population in other months was estimated by multiplying the highest longevity to the ratio of the population abundance in a particular month to the highest abundance.

The potential mosquito control effect of gravid trapping can be obtained by addition of the total number of mosquitoes captured and the total number of female progeny mosquitoes that there might have been in the absence of gravid mosquito trapping. The size of progeny mosquitoes can be estimated by a combination of three factors: the number of female progeny per a gravid female mosquito, total number of mosquitoes collected, and proportion of gravid mosquitoes in the total number of collected mosquitoes.

Results and Discussion

A literature search for life table characteristics of *Cx. quinquefasciatus* identified five studies and their available life table characteristics (Table 1). *Cx. quinquefasciatus*, formerly known as *Cx. pipiens fatigans*, is a nocturnal feeder with its daily peak biting activity from 10 p.m. to 2 a.m. (de Meillon & Sebastian, 1967). Successful blood feeding of a mosquito is essential not only for egg development, but for longer survival (Clements, 1992). A study design with a limited-time access to an animal host during the daytime does not represent natural conditions for blood feeding of *Cx. quinquefasciatus* (Walter & Hacker, 1974); this study design limitation might have affected successful blood feeding.

Temperature effect on longevity and oviposition of *Cx. quinquefasciatus* was also documented. *Cx. quinquefasciatus* lived longer but oviposited fewer eggs at ambient temperatures lower than 28 °C (Ciota, Matacchiero, Kilpatrik, & Kramer, 2014). Suleman and Reisen (1979) used lower temperatures, 22.8 ± 2.9 °C, for the experiment than 28.2 ± 1.9 °C, which is the average temperature of June through September in the Dallas–Fort Worth region for years 2000 to 2014 (National Weather Forecast Service Office, 2014). The

study by Kasule (1986) was conducted at temperatures of 24 to 27 °C. Kasule observed an average of 195.99 female progeny per female adult mosquito per generation (net reproductive rate) and 44.12 days of lifetime. In comparison, Suman and co-authors (2011), who conducted their study at temperatures of 26 to 28 °C, showed a lower average of net reproductive rate and longevity than the Kasule study.

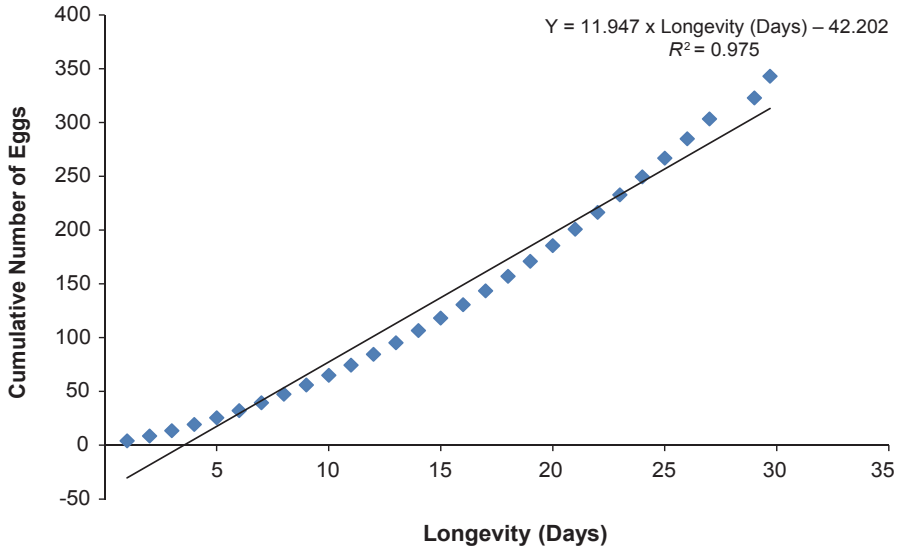
To generate a model that could conservatively estimate the size of female progeny in Fort Worth, Texas, Suman and co-authors' (2011) values of population life table characteristics were chosen as the experimental conditions and values most suitable for our study. They observed life table characteristics of five geographically different field strains of *Cx. quinquefasciatus*, including longevity and proportion of eggs to become adults. The authors also generated five strain-specific regression models for the number of eggs produced by a female mosquito with a particular age. To get a representative value for the five different strains, an average was taken in proportion of eggs to become an adult (0.63) and longevity (29.7 days) (Table 1). A daily average of the number of eggs from the five strain-specific regression models was calculated and the daily cumulative number of eggs produced until the chosen longevity (29.7 days) was plotted using SAS version 9.3 to get a new representative regression model for cumulative number of eggs laid over longevity (Figure 1). This regression model is described as Y = 11.947 x longevity (days) - 42.202.

Unlike the other characteristics, the generally accepted and used value 0.5 was taken as the proportion of female offspring, instead of 0.54 used in the study by Suman and co-authors (2011). Taken together, a model for the number of female adult progeny per female gravid adult was constructed and the developed model is described as Y = [11.947 x longevity (days) - 42.202] x proportion of eggs to become adult (0.63) x proportion of female adults (0.5).

A total of 4,274 female *Cx. quinquefasciatus* mosquitoes trapped from July 2 to August 6 were individually observed to determine if a mosquito carried mature eggs. The proportion of gravid mosquitoes varied with collection dates and ranged from 0.64 to 0.84. The proportion of gravid mosquitoes in total mosquitoes observed was 0.78 (Table 2) and this value was applied to estimate the total number of gravid mosquitoes out of the total mosquitoes collected.

FIGURE **1**

Estimated Number of Female Progeny per *Culex quinquefasciatus* Female Adult



Linear model derived from the oviposition models of Suman et al. (2011) for the number of eggs laid on a day of adult life.

TABLE **2**

Proportion of Gravid *Culex quinquefasciatus* Collected in CDC Gravid Traps in Fort Worth, Texas

Date of Collection	# of Trapping Sites	# of Mosquitoes Observed	Proportion of Gravid Mosquitoes
July 2, 2013	17	1,116	0.84
July 9, 2013	21	1,338	0.77
July 23, 2013	18	461	0.79
July 30, 2013	24	530	0.81
August 6, 2013	14	829	0.64
Total	94	4,274	0.78

Previous studies showed that the proportion of gravid mosquitoes in the CDC Gravid Traps varied with location and time of collection, type of oviposition attractant, and size and color of container for oviposition attractant (Irish, Moore, Derua, Bruce, & Cameron, 2013; McCardle, Webb, Norden, & Aldrich, 2004). The study by McCardle and co-authors (2004) reported 81% of *Cx. pipiens* and 91.5% of *Cx. restuans* that were collected in the Patuxent Research Refuge in Maryland were gravid. The other study by Irish and co-authors (2013) also reported 81% to 91% of CDC Gravid Trap-collected *Cx. quinquefasciatus* in Tanzania were gravid. The current study observed 78% gravid mosquitoes in the total females collected in CDC Gravid Traps, a proportion that seems compatible with those of other studies.

Environmental conditions greatly influence mosquito survival and longevity, determining population size of the future generation. This study assumed that longevity is the ultimate

TABLE **3**

Estimated Longevity and Potential Vector Control Effect of Gravid Mosquito Trapping on *Culex quinquefasciatus* in Fort Worth, Texas

Month	Total # of Female Mosquitoes Collected (A)	Proportion of Gravid Females (B)[a]	# of *Cx. quinquefasciatus*/ Trap Night (C)	Estimated Longevity (Days) (D)[b]	Estimated # of Female Progeny/Adult Female (E)[c]	Estimated Total # of Female Progeny (F)[d]	Estimated Potential Mosquito Control Effect (G)[e]
May	3,665	0.78	14.0	29.7	98.5	281,582	285,247
June	14,308		66.6	20.2	62.7	699,747	714,055
July	9,058		45.3	11.7	30.7	216,903	225,961
August	5,434		26.3	17.2	51.4	217,860	223,294
September	8,033		38.6	8.9	20.2	126,568	134,601
October	4,156		20.0	–	–	0	4,156
Total	44,654					1,542,660	1,587,314

[a]Proportion of gravid females was obtained from observation of 4,274 female *Cx. quinquefasciatus* that were collected in CDC Gravid Traps from July 2 through August 6, 2013.

[b]Longevity of the mosquito population in a particular month of X (D) was estimated by the formula: D = 29.7 days x the abundance in the X month/the highest abundance (66.6/trap night). The estimation was based on the assumption that the highest mosquito abundance in the month of X was produced by the parental mosquito population in the month of X - 1 with longevity of 29.7 days.

[c]Number of female offspring per adult female in each month (E) was estimated by the formula: E = total number of oviposited eggs estimated by the regression model in Figure 1, [11.947 x longevity (D) - 42.202] x proportion of eggs to become adult (0.63) x proportion of females (0.5).

[d]Estimated total number of female progeny (F) was calculated by the formula: F = A x B x E.

[e]Potential mosquito control effect (G) was estimated by the formula: G = A + F.

outcome of interactions between a mosquito and its environment. Thus, when population abundance in a particular month is the highest, the mosquito population in the previous month is assumed to have the longest longevity. In 2013, Fort Worth had the highest population abundance of *Cx. quinquefasciatus* in June (66.6 per trap night) and thus the May mosquito population was assumed to have the longest lifetime. This study applied 29.7 days for the longevity of the May mosquito population, the most conservative value among the identified (Table 1). Thereafter, longevity of the vector population in a particular month (X) was estimated by the product of the highest longevity, 29.7 days, multiplied by the ratio of population abundance of the next month (X + 1) to the highest abundance of 66.6 per trap night.

The average temperature of May and June in the Dallas–Fort Worth area from 2001 to 2014 was 23.8 °C and 28.3 °C, respectively. A recent study (Ciota, Matacchiero, Kilpatrik, & Kramer, 2014) showed median longevity of *Cx. quinquefasciatus* is estimated at 40 days at 24 °C and 25 days at 28 °C. Compared to the results of the Ciota study, the estimated longevity for the population of May and other months in our study are conservative. As there was no mosquito collection in November, the October mosquito population was assumed not to produce offspring at all, for a conservative estimation. Thus, an estimated longevity of the city mosquito population ranged from 8.9 to 29.7 days during the period of May through September (Table 3).

The generated model for the number of female progeny per female gravid mosquito was applied with the estimated longevity of a particular month to get the number of female progeny per a female adult collected in the month. This number was multiplied by the total number of female mosquitoes collected in the month and proportion of gravid females (0.78) to obtain the total number of female progeny that could have been produced. Finally, mosquito control effect of gravid mosquito trappings each month was estimated by adding the estimated number of female progeny that might have been produced without the mosquito trapping and the number of female adult mosquitoes captured by the trapping.

Fort Worth entomological surveillance collected a total of 44,654 female WNV vector mosquitoes from May to October 2013. Of the total collected, 40,498 mosquitoes were trapped during the period of May to September, which might have produced 1,542,660 female adult offspring in the city without mosquito trapping being included in the surveillance. The total WNV vector control effect of gravid mosquito trappings in 2013 would be the sum of the total female WNV vector mosquitoes collected (44,654) and the number of female offspring that might have been present (1,542,660) without trapping parent mosquitoes. Thus, the estimated potential WNV vector control effect of 2013 entomological surveillance activities in Fort Worth is 1,587,314 (Table 3).

Construction and application of a quantitative model can be made under certain assumptions. This study constructed a model for female progeny size of a gravid mosquito over longevity with life characteristics of *Cx. quinquefasciatus* observed in a laboratory setting. Thus, application of the developed model to estimate control effect of the gravid trapping assumed all captured gravid mosquitoes successfully locate an oviposition site and lay their egg raft, and the proportion of

eggs to become adult and longevity of adult females represent those of the field population. Survival and longevity of adult females in a field mosquito population have been estimated by the mark-release-recapture (MRR) technique or by dissection of female mosquitoes to assess parity rate (the number of times that a female has laid eggs) (David, Ribeiro, & Freitas, 2012). In the MRR method, emigration of mosquitoes from the study area underestimates actual survival rate and longevity. The parity-based survival rate and longevity are vulnerable to underestimation, as new adult female mosquitoes are continually added to the study population in a natural environment. Due to the above assumptions of both methods, survival rate and longevity from the studies with a field mosquito population can be underestimated. In addition, both methods require a trained professional to conduct a study.

Entomological surveillance is integral to IVM and provides information on the level of WNV virus activities in the vector mosquito population. It is quite common that the environmental health department or an equivalent in a local government is responsible for WNV vector surveillance and control. Sustainable operation of an entomological surveillance program in a local government often relies on maintenance of public recognition and appreciation of the program activities. Public appreciation of the program, however, often sharply decreases when WNV activities are low. In fact, public health agencies are experiencing a decrease in capacity to deal with vectorborne diseases during interepidemic years, which has resulted in increased vulnerability to an epidemic of a vectorborne disease (Association of State and Territorial Health Officials, 2007; Herring, 2010). Thus, it is important to maintain public recognition and appreciation of program activities.

This study used a novel approach to quantify a potential WNV vector control effect of gravid mosquito trapping and developed a model to estimate the size of female progeny from a gravid female parent mosquito over longevity. Despite limitations of the model application, the new approach and resulting model could be a practical tool for local WNV surveillance and control programs to estimate potential control effect of their entomological surveillance activities. This study may enhance significance of the mosquito surveillance program and its activities by adding potential control effect of mosquito surveillance activities. In addition, the new approach and model assessed in this study enable public health systems to quantify the potential control effect of the gravid mosquito trapping and the quantified effect can easily be presented to the public and program stakeholders.

Conclusion

A novel approach was used to estimate a potential control effect of entomological surveillance activities. A quantitative model was derived from available information to estimate the number of female progeny of an adult female mosquito of *Cx. quinquefasciatus*. This model then was applied with mosquito surveillance data to estimate a total number of female mosquito progeny that might have been produced in the absence of CDC Gravid Traps. Finally, a potential WNV vector control effect was estimated by the sum of the total number of progeny that might have been and the total number of captured mosquitoes. In 2013, mosquito trapping in Fort Worth was estimated to reduce 1,587,314 female WNV vector mosquitoes by capturing 44,654 female mosquitoes.

The application of this novel model can be used to estimate the WNV vector control effect of entomological surveillance activities where *Cx. quinquefasciatus* is the primary or predominant vector for WNV, and the quantified effect can easily be presented to and understood by the public and program stakeholders.

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GUEST COMMENTARY

Rewards and Lessons Learned From Implementation of a Healthy Homes Research Project in a Midwestern Public Health Department

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Abstract **Marion County Public Health Department (MCPHD) in Indianapolis, Indiana, was awarded funding in 2009 from the U.S. Department of Housing and Urban Development through the Healthy Homes Demonstration Grant Program as a part of the American Recovery and Reinvestment Act. This funding is currently supporting activities addressing health and safety hazards in homes of low- and very low-income residents living in an urban community within Marion County with an extensive history of heavy industry and lead smelting. One portion of this grant is being used to fund IRB-approved research conducted by MCPHD for the period of the grant. Development and implementation of this study has provided both unique challenges and positive opportunities for study participants, MCPHD, and community stakeholders. The following commentary provides insight into the benefits and rewards of implementing a successful study process, as well as challenges in implementing a community-based research study for the first time in a preexisting Healthy Homes Demonstration Grant Program health department.**

Introduction

There has been solid evidence demonstrating a strong link between housing (and home environment) and its impact on health. All facets of the residence have been shown to have an impact on health for those who dwell within: everything from basic air and water quality, materials used to build and treat the structures, to the physical surroundings nearby as with an industrial complex or a lush farm field using herbicides (Carozza, Elgethun, & Whitworth, 2008; Centers for Disease Control and Prevention, 2005; Chevier, Eskenzi, Bradman, Fenster, & Barr, 2007). The importance of healthy homes and the concern for reducing hazards that impact health were again brought to the national stage with the 2009 release of the surgeon general's call to address home hazards and their impact on the health of all Americans (U.S. Department of Health and Human Services, 2009). This report provided a summary of information regarding the well-documented links to the impact these hazards have on the health of people of all ages, particularly those most vulnerable such as the very young, pregnant women, or older adults.

During this same year, Marion County Public Health Department (MCPHD) in Indianapolis, Indiana, was awarded a Healthy Homes Demonstration Grant Program in April 2009 by the U.S. Department of Housing and Urban Development (HUD). This funding was targeted to support activities addressing health and safety hazards in privately owned rental and owner-occupied homes with low- and very low-income residents living in the Martindale-Brightwood neighborhood, an urban community in Indianapolis. This area has an extensive history of heavy industry and lead smelting throughout the past 60 years.

One portion of this grant is being used to fund institutional review board (IRB)-approved research conducted by the Lead Safe and Healthy Homes Department of MCPHD for a 36-month period. This study, "The Healthy Homes Demonstration Project—Phase I," examines the effects of providing cost-effective preventive measures in correcting residential safety hazards that produce disease and injuries in low-income populations.

A long-term goal of this study is to identify and promote cost-effective prevention measures to correct multiple residential safety hazards that produce disease and injuries in sensitive subgroups who may occupy low-income or substandard housing. The sensitive subgroups identified along with the heads of households are children, pregnant women, older adults, and people with disabilities. To date, of the 452 housing units and heads of households targeted, 220 have been enrolled and have received systematic healthy homes assessments, personalized plans of care, and moderate nonstructural modifications. These interventions included: older adult or handicapped accessibility, asthma trigger remediation, mold inspec-

tion and referrals, structural lead and blood lead testing and referrals for pregnant women and children 6 years of age and under, radon testing and referrals, and other nonstructural modifications and health referrals.

Final results are pending with the completion of the final phase of recruitment and implementation of interventions and data analysis. The development and implementation of this study has presented unique challenges and positive outcomes for MCPHD, study participants, and community stakeholders. Our guest commentary presents insight into some of the benefits and rewards of implementing a successful study-process, as well as the challenges in implementing a community-based research study for the first time in a preexisting Lead Safe and Healthy Homes program.

Characteristics of the Targeted Area, Participants, and Their Homes

The targeted area for this study is the Martindale-Brightwood neighborhood. It is an urban community and is considered to be one of the oldest neighborhoods in Indianapolis. It has had a long history of heavy industry and railroad activities in a densely populated residential area. In addition, over half (64%) the homes in this area were constructed before 1950, indicating a high probability that the paint within these homes contained lead.

Statistics related to poverty, educational level, and unemployment rates in this area reflect a critical need in this population. Martindale-Brightwood neighborhood's 1999 statistics showed 28% of the households were at or below 100% of the federal poverty level, which is higher than Marion County, where 9% of the households were at or below 100% of the federal poverty level during that same time period. The physical area identified included targeting six census tracts with the number of parcels ranging from 2,142 to 2,610. Included in this area was a neighborhood naturally occurring retirement community (WFYI Indianapolis, 2014).

To measure the effectiveness of the program in reducing hazards in residents' homes, each participant received four visits as part of the study. An initial home assessment was conducted, during which the participants were given information on the study and signed the necessary consents. The home assessment included a lead risk assessment and an environmental home assessment adapted from the National Environmental Education and Training Foundation's Pediatric Environmental Home Assessment Survey. Based on the home assessment, a low-cost toolkit was provided to each participant within two weeks of the initial visit. The toolkits were a combination of items to help reduce hazards in the home, such as smoke detectors, fire extinguishers, and mattress covers, as well as educational material to empower residents to make their homes safer and healthier. Two follow-up home assessments at 3 months and 6 months were used to measure any reduction in home health or safety hazards.

There have been 220 initial healthy homes assessments completed. The demographic information collected from the self-identified head of household participants indicates that the study population is predominantly female (78%), African American (84%), and own homes (82%). The estimated mean age is 57 years with a range from 24 to 100 years. The majority of participants have resided in Indiana for more than 20 years, and have lived in their current residence and in the Martindale-Brightwood area more than 10 years. Most participants had no education beyond high school (61%), with few having reported a college degree (6%). A significant percentage was without children under 17 in the home (10%). Homes were low income per the inclusion criteria, so the fact that 57% of the annual household incomes were below $30,000 is to be expected.

When participants were assessed regarding household configuration of family members with asthma, disability, and age composition, it was found that 38% of the participants had household members who had allergies or asthma and 56% had someone over 65 years and/or disabled living in the household. Additionally, participants reported that 87% of participants had Medicaid, Medicare, or Wishard Advantage (an indigent health insurance program). The majority of the homes (64%) were built prior to 1950 and only a few (14%) were built after 1978.

Key Components Necessary for Initiation and Implementation of Study

Altering the milieu for a portion of the Lead Safe and Healthy Homes Department from a service-only focus to a combined service/research focus presented challenges in the department and in the field. After identifying program objectives, the healthy homes team met weekly and worked on a structured plan that would not only meet the study objectives, but maintain Healthy Homes Demonstration Grant Program objectives. These objectives included concepts related to supporting public education and outreach, increasing public awareness for environmental safety and healthy homes, developing a professional healthy homes workforce, disseminating research findings with a focus on evidenced-based best practices, and furthering the principles of environmental justice and fair housing.

The healthy homes team identified three elements that have been essential for a smooth initiation and implementation of this process. The first and most critical has been the full commitment of the organizational leadership to facilitate the research study development process. This provided an opportunity for the study team to build on preexisting infrastructure resources and enhanced the ability to develop new resources in the program and in MCPHD. The second element is facilitating the evolution of the healthy homes research team from service orientation to a combination of research and service. In-house education and external research training and certification facilitated this transformative process. The third element—providing time and opportunity for socialization in the intricacies of human subjects research—was one of the most challenging and is an ongoing focus. We have identified these intricacies as

- identifying, acknowledging, and understanding how to deal with ethical components of the study;
- maintaining rigor and precision in reporting, documentation, and observation; and
- developing the ability to identify problems, errors, and procedural issues related to an incident.

Furthermore, no research study that is to be conducted in the community can hope to be successful without recognition, acknowledgement, and engagement of the community. To achieve this end, we utilized four methods.

1. Conducted an IRB-approved focus group pilot study with three representative groups of community members and discussed their views related to knowledge and understanding of healthy homes assessments, their views of what makes a healthy home, and

their feelings and concerns related to visits to their homes by a healthy homes inspector.
2. Worked to develop buy-in by neighborhood associations by having the healthy homes team members attend community meetings, network with community members, and work on collaboration and trust building prior to study recruitment and enrollment.
3. Identified and encouraged buy-in with local faith-based organizations and churches. We provided information after services regarding the pending study recruitment and enrollment.
4. Identified civic leaders locally, citywide, and in the mayor's office and sought out opportunities to provide information to these leaders.

Challenges and Solutions

As the study progressed, there were several challenges that presented over time (Table 1). The first challenge was delays in IRB approval of the study. Historically, the Lead Safe and Healthy Homes Department's experience has been with code compliance, not research. Navigating the necessary research safeguards was a new experience and staying on schedule while learning the procedures related to human subjects research was a challenge for departmental staff. The community's experience with MCPHD likewise was tied to code compliance and therefore many participants were initially skeptical of allowing the investigators to enter and inspect their home. Clearly stating the purpose of the study and assuring participants that investigators were not conducting code compliance inspections was crucial to recruitment. Furthermore, the low response rate to recruitment mailings likely was linked to the correspondence being thrown away without being read. Later mailings included an identifier on the envelope to differentiate the letter from other mailings the residents might have been receiving from MCPHD.

Another challenge was meeting HUD benchmarks and American Recovery and Reinvestment Act requirements. As recruitment proved more difficult than anticipated, it was difficult at times to meet these benchmarks and requirements. One solution was to increase staff for recruitment by using available staff from other programs to assist in door-to-door recruitment. Finally, as many participants were older adults, simply providing some of the toolkit items was insufficient. Many did not have the means or ability to install and use the toolkit items. Departmental staff identified community groups that were willing to assist with intervention installation to reduce this disparity. These challenges afforded us an opportunity to mature in the research process and finding solutions proved to be a rewarding experience.

TABLE **1**

Study Challenges and Solutions

Challenges/Barriers	Solutions
Institutional review board approval delays.	Persistence in working with the institutional review board.
Mailed applications thrown away without opening by potential participants.	Adding identifier on envelope indicating an application for the Healthy Homes Project is enclosed.
Potential study participants' fears: • Allowing strangers in their home. • Housing code enforcement.	Wearing Marion County Public Health Department-identifiable clothing and showing identification. Participating in neighborhood meetings to inform the public of intentions.
Balancing study timeline with U.S. Department of Housing and Urban Development benchmarks and American Recovery and Reinvestment Act funding spending requirements.	Conducting assessment and intervention activities outside of the study to maintain appropriate grant spend-down activities for nonresearch interventions.
Limited staff to work on a complex time-intensive study in addition to other duties.	Creative staffing—pulling available staff from other programs and utilizing senior nursing students and faculty to assist with recruitment prior to enrollment in study.
Physical installation of safety items such as smoke and carbon monoxide detectors and shower heads.	Identifying community groups willing to assist with intervention installation at no cost. The installer's information was given to participants who indicated a need for assistance with installation to maintain confidentiality in the study.

Rewards

The novice research team has identified positive outcomes associated with this process. One immediate outcome has been the adoption of healthy homes survey instruments outside of the study for data collection and entry in the everyday work of the Lead Safe and Healthy Homes Department. Another positive outcome from this process has been that knowledge gleaned in preparation for the study has enhanced staff understanding of older clients who may be at risk for unintentional home injuries and respiratory illnesses. The high percentage of older adults in the study has provided important information related to the notion of allowing opportunity for aging-in-place as well. As a result, the Lead Safe and Healthy Homes Department has initiated an aging program that includes case management for older individuals who suffer from respiratory disorders or for those who are at above-average risk for unintentional fall injuries.

Moreover, the Lead Safe and Healthy Homes Department has gained greater understanding of the nuances involved with human subjects research. Lessons learned from this experience include ethical treatment of participants, informed consent guidelines, data collection, and the importance of precision in initiation and application of study instruments and data collection. It is the healthy homes research team's belief that conducting this study has provided an opportunity for MCPHD to be viewed as an organization that strives for

excellence in providing knowledgeable, evidenced-based care and practice to the public by seeking new information related to the health of the population.

Conclusion

Research has an important role in the future of providing appropriate evidence-based care and practice in public health. The transformation from service orientation to a combination of research and service requires organizational commitment, dedicated partners, and the ability to build on preexisting infrastructure resources. This change can bring added value to the institution, as well as engendering a milieu of collaborative partnership and trust between the community and its public health organization.

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Did You Know?

The U.S. Department of Agriculture's Food Safety and Inspection Service (FSIS) recently posted its inaugural 50-state webinar, *Listeria* Controls at Retail, on YouTube at www.fsis.usda.gov/wps/portal/fsis/topics/regulatory-compliance/regulatory-education-video-seminars. The video was recorded in September 2015 and includes speakers from FSIS and the Centers for Disease Control and Prevention.

DIRECT FROM CDC ENVIRONMENTAL HEALTH SERVICES BRANCH

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Preventing Legionnaires' Disease: Environmental Health Expertise Is Key

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

In these columns, EHSB and guest authors share insights and information about environmental health programs, trends, issues, and resources. The conclusions in this article are those of the author(s) and do not necessarily represent the views of CDC.

CDR Jasen Kunz is an environmental health subject matter expert for Legionnaires' disease at CDC's National Center for Environmental Health/EHSB. LCDR Laura Cooley is an epidemiology subject matter expert for Legionnaires' disease at CDC's National Center for Immunization and Respiratory Diseases/Division of Bacterial Diseases.

About 5,000 cases of Legionnaires' disease and at least 20 outbreaks are now reported to the Centers for Disease Control and Prevention (CDC) each year (Adams et al., 2015). People can get Legionnaires' disease or Pontiac fever (collectively known as legionellosis) by inhaling aerosolized water droplets containing *Legionella* bacteria (Fields, Benson, & Besser, 2002). Legionnaires' disease, the more serious type of legionellosis, can cause severe pneumonia (lung infection) and is deadly for about 1 in 10 people who get it (Dooling et al., 2015). Pontiac fever causes a milder, influenza-like illness. Legionnaires' disease was named after an outbreak of pneumonia in 1976 among people attending an American Legion convention in Philadelphia.

Legionella is rarely, if ever, transmitted from person-to-person (Correia et al., 2016); it is found naturally in the environment, usually in warm water. Exposure to freshwater generally does not lead to disease. In human-made water systems, however, *Legionella* can amplify and spread to susceptible hosts via aerosolization from contaminated water. As such, keeping *Legionella* out of building water supplies and cooling towers, as well as pools, hot tubs, and fountains, is key to preventing infection and outbreaks (Garrison et al., 2016). Prevention is critical as *Legionella* was the cause of 66% of all potable water-associated outbreaks reported to CDC during 2011–2012 (Beer et al., 2015).

Environmental Health Expertise Is Key

To prevent Legionnaires' disease we must understand the environmental factors that allow *Legionella* bacteria to survive and reach a susceptible host. Due to the relationship of *Legionella* to the environment, environmental health practitioners are ideally situated to provide expertise essential to both responding to Legionnaires' disease outbreaks and preventing future ones. Working with epidemiologists and public health laboratorians, environmental health practitioners need to be proficient in applying environmental interventions (e.g., recommending potable water flushing procedures to address *Legionella*-contaminated water in an unoccupied building wing) in outbreak settings to stop outbreaks and prevent future ones. Environmental health response in Legionnaires' disease outbreaks contributes to improved prevention practices. Additionally, they can help translate lessons learned from outbreak response into evidence-based prevention guidance for building owners and managers.

In June 2016, CDC released a *Vital Signs* focused on Legionnaires' disease (www.cdc.gov/vitalsigns) emphasizing the importance of building owners and managers to use new industry standards for the primary prevention of Legionnaires' disease in building water systems. This standard, the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard 188-2015, intends to reduce the risk of Legionnaires' disease and calls for the development and implementation of water management programs in buildings with large or complex building water systems. CDC stated that widespread use of these standards could reduce the number and size of Legionnaires' disease outbreaks and save lives. Moving forward, environmental health practitioners will

FIGURE **1**

Developing a Water Management Program

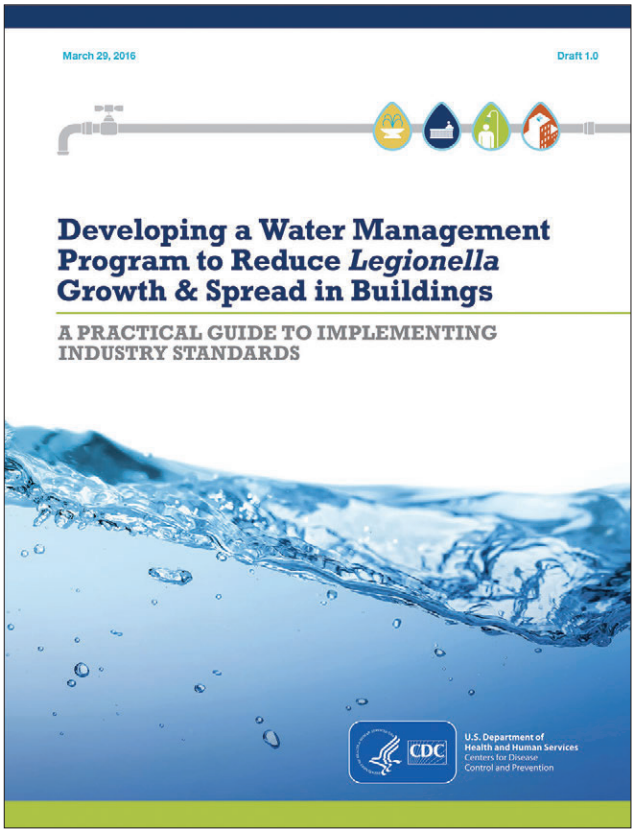
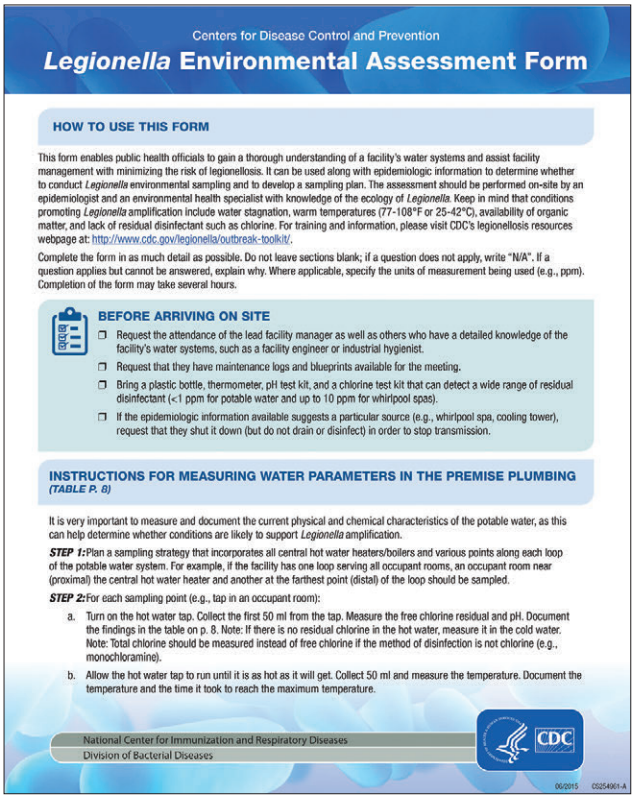


FIGURE **2**

***Legionella* Environmental Assessment Form**



be instrumental in facilitating the implementation and use of this new industry standard.

New Legionnaires' Disease Prevention and Outbreak Response Tools

To assist state and local health departments and environmental health practitioners, CDC developed new resources focused on preventing and investigating individual cases, clusters, and outbreaks of Legionnaires' disease (www.cdc.gov/legionella). Health departments can use CDC's new toolkit, *Developing a Water Management Program to Reduce* Legionella *Growth & Spread in Buildings: A Practical Guide to Implementing Industry Standards*, dedicated to developing and implementing a water management program to inform conversations with building owners and managers on how to reduce the risk of *Legionella* growth and spread in their building water systems (Figure 1).

Regarding Legionnaires' disease response, CDC also updated the *Legionella* Environmental Assessment Form (Figure 2) used to describe a facility's water system and help determine when and where to conduct *Legionella* environmental sampling. If sampling is warranted, health departments can use CDC's sampling procedure to collect environmental samples for *Legionella* culture during a cluster or outbreak investigation, or when cases of disease may be associated with a facility. CDC also has a sample data sheet that health departments can use to keep track of environmental samples taken for *Legionella* culture during an investigation.

In addition, CDC has a series of six new instructional videos for conducting environmental investigations of legionellosis outbreaks. Short training videos are available on the following topics.

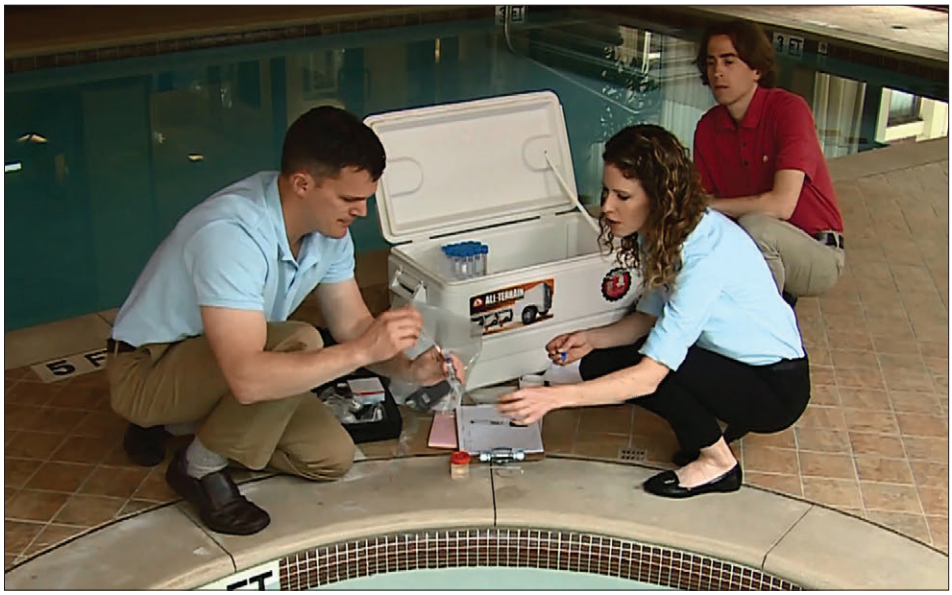
- *Legionella* Ecology and an Introduction to Environmental Health and Engineering: Learn why and where *Legionella* amplifies, as well as the basics of how cooling towers, premise plumbing, and whirlpool spas work.
- Conducting and Interpreting the Environmental Assessment: Learn useful tips about conducting an environmental assessment and how to interpret the results of key questions on CDC's *Legionella* Environmental Assessment Form.
- How to Make a Sampling Plan: Learn how to make a plan for the number of water and biofilm samples to take and where to take them.
- How to Sample Potable Water: Learn CDC's procedure for collecting potable water samples for *Legionella* culture.
- How to Sample Cooling Towers: Learn CDC's procedure for collecting environmental samples from cooling towers for *Legionella* culture.
- How to Sample Spas and Fountains: Learn CDC's procedure for collecting environ-

Legionella Quick Links

- Centers for Disease Control and Prevention's (CDC's) new *Legionella* Web site: Toolkit for implementing a building water management program, includes an environmental assessment form, sampling procedures, and instructional videos for investigating and preventing legionellosis outbreaks. www.cdc.gov/legionella/health-depts/inv-tools-cluster/environmental-inv-tools.html
- Disinfection of Hot Tubs Contaminated With *Legionella*: Fact sheet with best practices for how to remediate hot tubs. www.cdc.gov/legionella/downloads/hot-tub-disinfection.pdf
- American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Guideline 12-2000: Minimizing the Risk of Legionellosis Associated with Building Water Systems: Guideline providing information regarding the ecology of *Legionella* and guidance to minimize and remediate colonization in building water systems. www.techstreet.com/products/232891
- ASHRAE Standard 188-2015: Legionellosis: Risk Management for Building Water Systems (ANSI Approved): Standard establishing minimum risk management requirements for building water systems to prevent legionellosis. www.techstreet.com/ashrae/products/1897561?ashrae_auth_token
- Frequently asked questions about ASHRAE Standard 188-2015: Legionellosis: Risk Management for Building Water Systems. www.cdc.gov/legionella/health–depts/ashrae-faqs.html
- CDC *Vital Signs* on Legionnaires' Disease: CDC Reports and resources including practical guides, an infographic fact sheet, and more. www.cdc.gov/vitalsigns/legionnaires

mental samples from spas and fountains for *Legionella* culture (see photo above).

To get started, explore CDC's new Legionnaires' disease prevention and outbreak response tools and related resources noted in the *Legionella* Quick Links sidebar. You just might prevent the next Legionnaires' disease outbreak!



Environmental investigators sample a spa.

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DIRECT FROM CDC ENVIRONMENTAL PUBLIC HEALTH TRACKING NETWORK

Mikyong (Meekie) Shin, MPH, DrPH

Kanta Sircar, MPH, PhD

Tracking Carbon Monoxide Poisoning to Better Understand How People Are Poisoned

Editor's Note: **As part of our continuing effort to highlight innovative approaches and tools to improve the health and environment of communities, the *Journal* is pleased to publish a bimonthly column from the Centers for Disease Control and Prevention's (CDC's) Environmental Public Health Tracking Network (Tracking Network). The Tracking Network is a system of integrated health, exposure, and hazard information and data from a variety of national, state, and city sources. The Tracking Network brings together data concerning health and environmental problems with the goal of providing information to help improve where we live, work, and play.**

Environmental causes of chronic diseases are hard to identify. Measuring amounts of hazardous substances in our environment in a standard way, tracing the spread of these over time and area, seeing how they show up in human tissues, and understanding how they may cause illness is critical. The Tracking Network is a tool that can help connect these efforts. Through these columns, readers will learn about the program and the resources, tools, and information available from CDC's Tracking Network.

The conclusions of this article are those of the author(s) and do not necessarily represent the views of CDC.

Meekie Shin is an epidemiologist in the Environmental Health Tracking Branch. She is a subject matter expert on tracking carbon monoxide poisonings, heart attacks, and reproductive birth outcomes. Kanta Sircar is an epidemiologist in the Air Pollution and Respiratory Health Branch. She is a subject matter expert on carbon monoxide poisoning and air pollution epidemiology.

On an evening in December 2014, a teenager passed out after finishing a hockey game in Lake Delton, Wisconsin. Other players and spectators reported headaches, nausea, vomiting, and dizziness. Local emergency response staff were contacted and they conducted an air quality test upon arrival at the ice arena. The test revealed dangerously high levels of carbon monoxide (CO). Response staff worked with four area hospitals to triage people for appropriate care. In total, 92 people were seen, with two individuals requiring hyperbaric oxygen treatment (Vogt, Christenson, Olson, & Creswell, 2015).

Tracking CO Poisoning Mortality and Morbidity

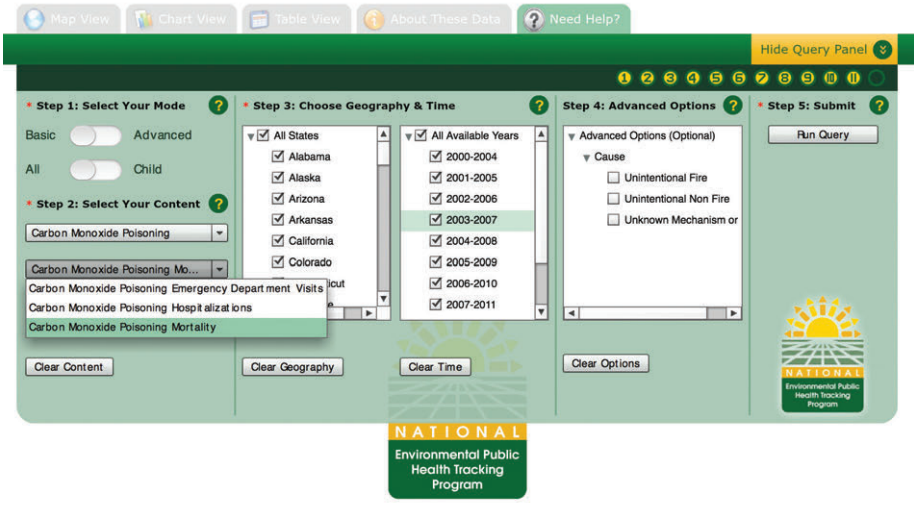
By tracking cases of CO poisoning and investigating their causes, public health findings have provided information to inform the development of laws and regulations. These developments include requiring CO detectors in new homes and other structures; engineering solutions to reduce the amount of CO emitted by appliances; and health education campaigns to promote CO detector use, regular maintenance of appliances, and proper use of generators following a power outage.

For decades, the Centers for Disease Control and Prevention (CDC) and state and local health departments have seen a critical need for public health solutions to CO poisoning. In 2013, the Council of State and Territorial Epidemiologists updated its CO poisoning position statement. They recommended CDC collect data on CO poisoning cases reported to state and local health departments, summarize it, and publish a national summary of CO poisoning (Council of State and Territorial Epidemiologists, 2013).

Planning and implementing this collection of data required the joint expertise of two programs at CDC's National Center for Environmental Health, Division of Environmental Hazards and Health Effects. CO poisoning mortality and morbidity surveillance is a collaboration between the Air Pollution and Respiratory Health Branch (APRHB) and the Environmental Health Tracking Branch. APRHB provides subject matter expertise in quantifying, investigating, and preventing CO poisoning through behavioral education (CDC, 2016a). The Tracking Branch guides

FIGURE **1**

Tracking Portal Displaying Carbon Monoxide Poisoning Indicators



surveillance activities and provides a platform for displaying the CO poisoning data. This platform, the National Environmental Public Health Tracking Network (Tracking Network), is a multitiered, web-based system of integrated health, exposure, and hazard information and data with components at national, state, and local levels. CO poisoning is one of the content areas included on the Tracking Network.

CO Poisoning Data

Working with APRHB and state and local partners, the Tracking Branch developed uniform case definitions using death certificate data and hospital and emergency department databases to measure the national burden of CO poisoning. There are three CO poisoning indicators on the Tracking Network: CO poisoning mortality, CO poisoning emergency department visits, and CO poisoning hospitalizations (Figure 1). Each indicator has three standardized measures: number of cases (count), crude rate (per 100,000 population), and adjusted rate (per 100,000 population). Also, each measure has an advanced option based on the CO poisoning cause: fire related, nonfire related, and unknown. All data are shown only at the state level in order to protect confidentiality of data and produce stable rates. For the mortality indicator, CDC combined 5 years of data to calculate the count and prevalence measures. The CO poisoning indicators related to the hospital and emergency department visits are calculated for single years.

Data for unintentional CO poisoning deaths, hospitalizations, and emergency department visits can be viewed in charts, maps, and tables on the Tracking Network. More information about the data and its limitations is available on the Tracking Network at www.cdc.gov/ephtracking. Additional data are available through the state and local tracking program Web sites (CDC, 2016b).

Tracking CO Poisoning at State and Local Health Departments

Recognizing CO poisoning as a preventable public health problem, many state health departments have established programs to help reduce the incidence of CO poisoning. CO poisoning monitoring by Tracking Program grantees has supported several public health actions, including identification of novel sources of CO exposure (e.g., the off-road motorsport known as mudbogging, indoor pool heaters, and bridge construction work), support for emergency response, and delivery of targeted messages to at-risk populations. A great example comes from Wisconsin.

Spurred by the CO poisoning incident at the ice rink in Lake Delton, the Wisconsin Tracking Program realized the state health department needed an active system to notify staff when a mass CO poisoning occurs. Wisconsin Poison Center leadership worked with Tracking Program epidemiologists to create an alert system. The new alert system sends an e-mail to tracking staff when an unusually high number of poisoning calls occur within a defined time frame. Tracking staff are now equipped to alert local public health authorities to potential CO poisoning issues and to provide guidance and technical assistance as needed. As Wisconsin's Tracking Program established the alert system, health department staff have access to near real-time information about mass CO poisoning in the state—information that can be used to prevent future events like the one in Lake Delton (Vogt et al., 2015).

Carbon Monoxide (CO) Poisoning

CO is a colorless, odorless, nonirritating gas that is produced through the incomplete combustion of hydrocarbons (U.S. Environmental Protection Agency, 2016). Sources of CO include combustion devices (e.g., boilers and furnaces), motor vehicle exhaust, generators and other gasoline or diesel powered engines, gas space heaters, woodstoves, gas stoves, fireplaces, tobacco smoke, and various occupational exposures (Council of State and Territorial Epidemiologist, 2013).

Breathing high levels of CO can cause severe illness and even death in just minutes. Every year, approximately 450 people in the U.S. die as a result of unintentional, nonfire related exposure to this toxic gas, and thousands more across the U.S. require emergency medical care for illness caused by CO poisoning (Centers for Disease Control and Prevention, 2008; Sircar et al., 2015). More cases of CO poisoning occur in the winter than in the summer, and after a natural disaster when utilities are down and people turn to alternative heating and energy sources.

For more information, check out the CO poisoning and the environment infographic at http://ephtracking.cdc.gov/showCOEnv.action.

Sharing Success Stories of Preventing Carbon Monoxide (CO) Poisoning

The Maine Department of Public Health has a long-standing focus on CO poisoning. In 2012, the Maine Tracking program identified two CO poisoning deaths from off-roading. These deaths were the first time that Maine's program encountered CO poisoning due to off-roading. They rapidly alerted public health staff to the new risk, created advisories, and brought awareness to the problem. They also shared their findings with other state health departments to spread awareness of the issue.

The Kansas Department of Public Health received a report that more than two dozen children were stricken with sudden, severe headaches and nausea at an indoor pool party held at a hotel in 2014. Tracking program and state health department public information staff developed an awareness campaign with educational materials that warned residents about CO risks and provided ways to prevent exposures. Messages were shared through statewide news releases and social media.

More success stories about CO poisoning and other environmental health topics can be found at www.cdc.gov/nceh/tracking/successstories.htm.

Future Directions

CO poisoning is preventable. APRHB and the Tracking Branch are working together to improve nationwide surveillance efforts to better capture the burden of CO poisoning and to identify the most vulnerable populations. One approach will be to add CO poisoning data from the National Poison Data System, which is compiled from poison control centers. The programs will collaborate to evaluate different public health interventions to determine if CO poisonings can be reduced. One area of focus is to inventory current state laws and regulations about CO alarm usage and to provide data to better inform regulators. As CO poisoning continues to be an important issue in post-disaster settings, the programs will also continue to collaborate with partners to develop public health tools, such as CDC's CO Poisoning Prevention Toolkit to help alert people about CO poisoning and decrease CO poisoning-related morbidity (National Public Health Information Coalition, 2014).

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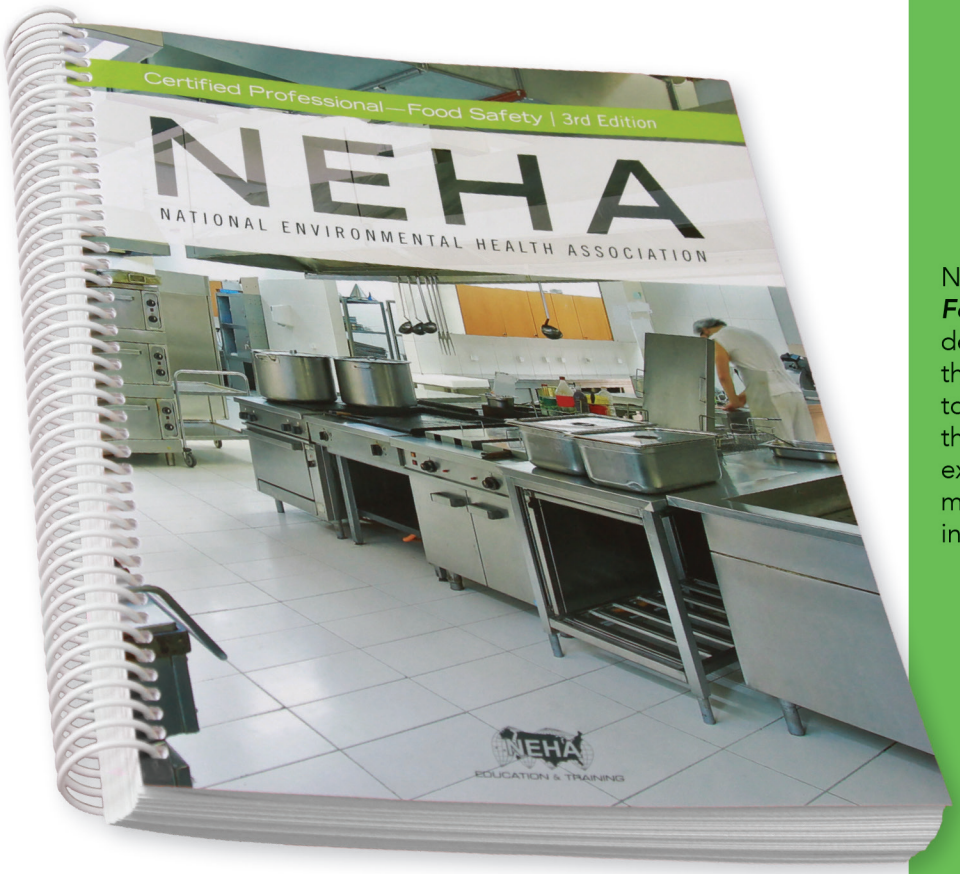

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JEH QUIZ

FEATURED ARTICLE QUIZ #1

Impacts of Industrial Wind Turbine Noise on Sleep Quality: Results From a Field Study of Rural Residents in Ontario, Canada

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Quiz Registration

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➔ Quiz deadline: October 1, 2016

1. Environmental noise has been associated with __ in previous studies.
   a. cognitive performance
   b. annoyance
   c. cardiovascular disease
   d. sleep disturbance
   e. all the above

2. Industrial wind turbines (ITWs) have been associated with annoyance and decreased health-related quality of life.
   a. True.
   b. False

3. In this study, a random sample of __ residents in the exposed community and __ residents in the unexposed community were selected for door-to-door recruitment.
   a. 12; 10
   b. 15; 12
   c. 29; 25
   d. 50; 56

4. The final participation rate for the study was
   a. 33%.
   b. 43%.
   c. 48%.
   d. 50%.

5. Reasons for exclusion in the study included
   a. use of sleep medication.
   b. location of the bedroom in the basement of the house.
   c. diagnosis of a preexisting sleep disorder.
   d. a and c.
   e. all the above.

6. __ were used to provide more detailed information on perceptions of the quality of sleep and the causes of awakenings.
   a. Actigraphy devices
   b. Video cameras
   c. Sleep diaries
   d. Family interviews

7. The __ group reported a greater frequency of poor sleep nights.
   a. exposed
   b. unexposed

8. For the exposed group, __ was reported as the greatest source of awakenings.
   a. child or partner
   b. use of bathroom
   c. pain
   d. other

9. __ and __ showed the largest amount of variation between the exposed and unexposed groups.
   a. Sleep onset latency; time in bed
   b. Sleep efficiency; wake after sleep onset
   c. Time in bed; total sleep time
   d. Total sleep time; sleep efficiency

10. Factors such as __ may have impacted the study's ability to demonstrate a statistically significant relationship between IWTs and poor sleep.
    a. a small sample size
    b. a lack of a true association
    c. uncontrolled confounders
    d. a and c only
    e. all the above

11. Limitations of the study include a modest sample size and subsequent low statistical power.
    a. True.
    b. False.

12. Barriers to community participation in studies like this one include
    a. organized lobbying against participation.
    b. a lack of trust in researchers
    c. beliefs that research cannot provide a positive impact.
    d. all the above.
    e. none of the above.

JEH Quiz #5 Answers

March 2016

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

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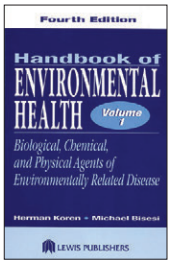
Handbook of Environmental Health, Volume 1: Biological, Chemical, and Physical Agents of Environmentally Related Disease (Fourth Edition)

Herman Koren and Michael Bisesi (2003)



A must for the reference library of anyone with environmental health concerns, this book focuses on factors that are generally associated with the internal environment. It was written by experts in the field and copublished with the National Environmental Health Association. 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.

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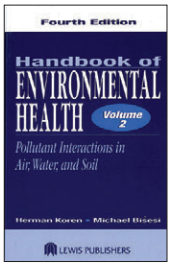

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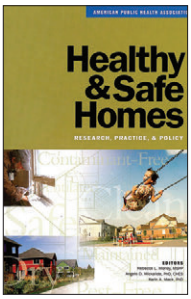

This book marks an exciting advance in the effort to ensure that people across all socioeconomic levels have access to healthy and affordable housing. It provides practical tools and information to make the connection between health and housing conditions relatable to everyone. The book brings together perspectives from noted scientists, public health experts, housing advocates, and policy leaders to fully explain the problem of substandard housing that plagues our nation and offers holistic, strategic, and long-term solutions to fix it. The many experts who have contributed to this book lay out smart approaches to help achieve the goal of making healthy housing accessible to all. Expanding access to healthy and affordable housing is a first step to creating a country of healthier people. Study reference for NEHA's Healthy Homes Specialist credential exam.

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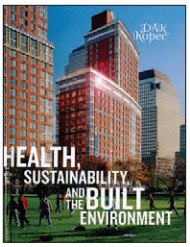

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Colorado
September 21–23, 2016: Annual Education Conference, hosted by the Colorado Environmental Health Association, Breckenridge, CO. For more information, visit www.cehaweb.com/aec/2016-aec.

Connecticut
September 21–22, 2016: 54th Annual Yankee Conference, hosted by the Connecticut Environmental Health Association, Mystic, CT. For more information, visit www.cteha.org.

Florida
July 13–17, 2016: Annual Education Meeting, hosted by the Florida Environmental Health Association, Sarasota, FL. For more information, visit www.feha.org/events.

Illinois
October 27–28, 2016: Annual Educational Conference, hosted by the Illinois Environmental Health Association, East Peoria, IL. For more information, visit www.ieha.coffeecup.com/calendar.html.

Indiana
September 26–28, 2016: Fall Conference, hosted by the Indiana Environmental Health Association, Michigan City, IN. For more information, visit www.iehaind.org/Conference.

Iowa
October 18–19, 2016: Fall Conference, hosted by the Iowa Environmental Health Association, Marshalltown, IA. For more information, visit www.ieha.net/2016FallEHConference.

Kansas
September 28–30, 2016: Fall Conference, hosted by the Kansas Environmental Health Association, Manhattan, KS. For more information, visit www.keha.us.

Montana
September 27–28, 2016: MEHA/MPHA Conference, hosted by the Montana Environmental Health and Public Health Associations, Billings, MT. For more information, visit www.mehaweb.org.

North Dakota
October 18–20, 2016: Fall Education Conference, hosted by the North Dakota Environmental Health Association, Bismarck, ND. For more information, visit http://ndeha.org/wp/conferences.

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October 10–14, 2016: Annual Educational Conference, hosted by the Texas Environmental Health Association. For more information, visit www.myteha.org.

Wyoming
October 3–6, 2016: Annual Education Conference, hosted by the Wyoming Environmental Health Association and Wyoming Food Safety Coalition, Sheridan, WY. For more information, visit www.wehaonline.net.

TOPICAL LISTING

Recreational Waters
October 19–21, 2016: 13th Annual World Aquatic Health Conference, hosted by the National Swimming Pool Foundation, Nashville, TN. For more information, visit www.thewahc.org.

Corresponding Author and Subject Index

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5	**Jo Anne Balanay, PhD, CIH, et al.** Seat Belt Usage Interventions for Motor Vehicle Crash Prevention on the Pine Ridge Indian Reservation, South Dakota	78.6 Jan/Feb 2016 Pages: 46–52	Community Nuisances/Safety	Public Health/ Safety			
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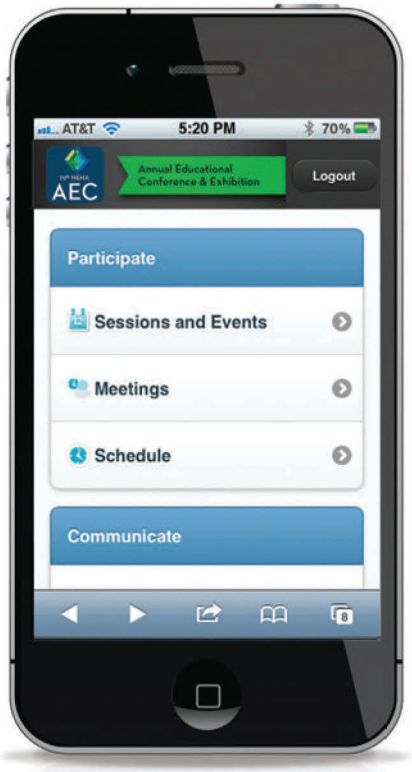

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NEHA **NEWS**

A Day in the Life of an Environmental Health Professional Blog

Did you know that NEHA has a blog that follows the work of environmental health professionals across the country, and even that of staff members from the NEHA office? You can find all these blogs at www.neha.org/membership-communities/get-involved/day-in-life. To give you a taste of what we've been posting, below is the text from an April 2016 blog that was authored by Solly Poprish, NEHA's Centers for Disease Control and Prevention's Public Health Associate Program Intern.

Together with the body art industry, the Food and Drug Administration, the Association of Food and Drug Officials, and state and local regulators, NEHA is working to revise its Body Art Model Code (BAMC). The group is working to update the BAMC in a way that is reflective of current body art trends and procedures, as well as ensure it is relevant and implementable to industry professionals.

Earlier this year, I accompanied a local environmental health specialist on a body art studio inspection. The tattoo shop had a very cool aesthetic with exposed brick, art, and repurposed decorations on the walls; the tattoo artists were friendly and accommodating.

Reid Matsuda is a body art studio inspector for the City and County of Denver. He provided me with insight into the inspection process and what individuals getting tattoos should look for when patronizing a studio.

"The biggest thing I would stress in terms of what patrons should look for is that the artists are opening the packaging in front of them. Some artists like to set up and prep for a client and that is great—as long as the sterilized items stay in the sterile packaging until the client is there to witness the sterile seal being broken. Otherwise, you never really know what is sterile and what isn't," Matsuda shared with me.

He went on to say, "Also make sure they offer extensive aftercare instructions and bandage the wound prior to leaving. If for a second you feel like you are in a production line, step away. This is a piece of art that is going to follow you around for the rest of your life and if artists or managers don't give you the time to thoroughly explain risks and care, you are in the wrong place."

As tattoos become more and more popular, it's important to recognize that getting work done at a studio that does not properly follow appropriate health codes can lead to serious repercussions.

As an inspector, the main things that Matsuda looks for are

- general cleanliness;
- hand sinks with hot water,
- expiration dates on ink, needles, tubes, grips, peel packs, etc.;
- nitrile gloves (petroleum products break down the latex barrier within 15–20 minutes of use);
- sharps and biohazard containers (sharps go in a rigid, red bin; biohazards are prominently labeled in a red bag); and
- cleaning supplies (disinfectants versus sterilizers) and making sure they at least have Madacide to target hepatitis and HIV.

As we work on revising the BAMC, we recognize how vital it is to bring together industry and regulatory professionals. We look forward to the outcome of this partnership and value the expertise of all individuals as we move through this process.

Do you have a comment to share about our work on revising the BAMC? Is your interest piqued to see what other blogs we have posted? If so, please join the conversation by going to www.neha.org/membership-communities/get-involved/day-in-life.

NEHA's New Mentorship Program

Through a grant from the U.S Environmental Protection Agency's Office of Pesticide Programs, NEHA is excited to begin a new mentorship program for developing school integrated pest management (IPM) capabilities. This program will provide mentorship between local health departments and rural or underserved schools to facilitate the use of IPM in school buildings.

The target audience for this program is school districts, IPM team members, facility and maintenance departments, janitorial staff, school administration, local health department inspectors, and health educators. By developing an IPM school program, schools and students will benefit by reducing attrition, exposure to pesticides and pests, and exposure to potential allergens and asthma triggers. Additionally, schools will be able to save money on pest management and build stronger partnerships between their school district and local health department.

Over the course of the next two years, activities will include

- development of mentorship program criteria and selection of participants,
- development of a toolkit and resource list for schools around IPM techniques and activities,
- facilitation of meetings between mentors and mentees,
- development and delivery of IPM webinars focused on needs of mentorship participants,
- development of a model guide for sustaining the mentorship program,
- and establishment of baseline IPM activities and related data for mentees.

Is your school district interested in participating in this program? If so, keep an eye out for program criteria and participant selection announcements coming soon. You can also contact Vanessa DeArman at vdearman@neha.org.

NEHA Credential Renewals Go Digital

NEHA's credentialing department is excited to announce that current credential holders may now renew their credential online (www.neha.org/membership-communities/renew). Credentialing has made significant steps to go paperless for items such as renewal notices, applications, and several different forms. E-mailed renewal notices are a huge step in becoming greener as we used to mail out over 650 paper renewal notices every month. Credential renewal notices will be sent via e-mail, so please make sure all your contact information is updated in your My NEHA profile.

DirecTalk
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extended to visitors while scores of children milled about chattering in excitement.

A representative from the Malawi Ministry of Health was with us to present a certificate of ODF status to the village chief. ODF, what the heck is that? ODF stands for open defecation free status. Over the last year the village chief, with energy and leadership largely provided by community mothers (ladies, my hats off to you), ensured that every village hut had its own latrine. No longer would defecation in nearby shrubberies and farmland be acceptable or necessary. See the photo to the right of a cool hand washing station found in the village.

Environmental health is featured as a central tenant of life and a cause for celebration. If they recognize the centrality of environmental health in Malawi, we should be able to advance that sensibility here at home. The United Nations gets it. Tiny villages in Malawi get it.

Environmental health professionals are a community axis and access resource, at home and abroad. We are the foundation for community resilience, critical to avoiding anarchy (think of the Freddie Gray riots in Baltimore), and essential to the sustainability of our way of life. While distasteful, I intend to follow the advice of Chicago Mayor Rahm Emanuel, "You never want a serious crisis to go to waste."

A unique hand washing station found in a rural Malawi village.

With Zika, Flint, and extreme weather in the news, NEHA will advance the proposition that our profession is an axis around which life, as we know it, hinges. We are currently advocating through Congress for a national standard to establish our Registered Environmental Health Specialist/Registered Sanitarian credential, or state equivalents, as the gold standard for the environmental health practice. Let me be clear, I believe every citizen in every community should expect a baseline or foundational competency in its environmental health workforce, and uniform credentialing is one step in that direction.

Secondly, we are a community access resource. We are the "connectors" in most communities because we know and work with most everyone, and frankly, we are central to a civilized existence. Land use planning, food, water, the built environment, air quality, vector control, healthcare-acquired infections, One Health—these are us! I will share ideas on how to exploit our latent influence in future columns.

The DRR panel convened at the 2016 Preparedness Summit hit the nail on the head. A strong and centralized environmental health workforce is critical to the functioning of civil society. NEHA is working around the clock to ensure you are at the table, and not on the menu.

Dave

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DirecTalk MUSINGS FROM THE 10TH FLOOR

David Dyjack, DrPH, CIH

DRR, Sendai, & ODF

The National Academies of Sciences, Engineering, and Medicine panel on disaster risk reduction (DRR) for health professions was convened in April at the 2016 Preparedness Summit in Dallas, Texas. The panel included some familiar and unfamiliar faces. From the familiar category were Dr. Mark Keim, founder of DisasterDoc (http://disasterdoc.org), and Mollie Mahany from the Centers for Disease Control and Prevention's (CDC's) National Center for Environmental Health (NCEH). From the less familiar, but no less important, camp were individuals representing food security for the city of Baltimore; emergency preparedness for Jackson County, Illinois; and the Medical Reserve Corps from Snohomish, Washington. Yours truly represented the environmental health profession.

The presentations and ensuing dialogue were striking in that nearly every illustration and case study described by the speakers were environmentally oriented, such as earthquakes, tsunamis, and Zika. The stunning centrality of environmental health issues to most disaster scenarios is only surprising in that the Public Health Emergency Preparedness (PHEP) capabilities do not reflect our profession's essential and influential role in the health of the nation. CDC developed 15 PHEP capabilities to serve as national public health preparedness standards, ostensibly to assist state and local public health departments in their strategic planning. How is it there is no PHEP capability for environmental health?

Environmental health professionals are a community axis and access resource.

I recently visited Dr. Stephen Redd (RADM, U.S. Public Health Service), director of CDC's Office of Public Health Preparedness and Response. Dr. Redd is a committed and highly competent professional whose office is responsible for all of CDC's public health preparedness and response activities. I posed the question to him during my visit to Atlanta, "Why is there no environmental health PHEP capability?" To his credit, Dr. Redd acknowledged the absence and suggested it was embedded in other capabilities. Nonetheless, how can "nonpharmaceutical interventions" merit its own capability, and environmental health not? This line of questioning is not a simple, jealous matter of "me, too," but more a matter of national security. The last time I looked, food, water, and shelter were essential elements of life.

At least the United Nations gets it. The *Sendai Framework for Disaster Risk Reduction, 2015–2030* was adopted at the Third United Nations World Conference in Sendai, Japan, on March 18, 2015. The *Sendai Framework* articulates the need for improved understanding of disaster risk in all its dimensions of exposure, vulnerability, and hazard characteristics.

NEHA, through its membership and participation in the International Federation of Environmental Health, is part of a consortium that has applied to the United Nations to be the Secretariat for environmental health workforce capacity building efforts in support of the *Sendai Framework*. Our presence and credibility is largely predicated on CDC/NCEH's Environmental Health Training in Emergency Response program developed by Martin Kalis in collaboration with the Federal Emergency Management Agency's Center for Domestic Preparedness, the Food and Drug Administration, and other partners and colleagues. This amazing training program receives precious little attention here in the U.S., and is at risk of being eliminated by our government. The irony of a CDC designed and developed environmental health workforce capacity building program that is more recognized and valued outside the U.S. should be a national embarrassment.

Environmental health continues to be a central feature of life around the globe. It was a week ago yesterday (as I write this column) that I visited a small village a two-hour vehicle ride from Lilongwe, the capital of Malawi. The village was located along a dusty, dirt road a few kilometers from the nearest pavement. The village women greeted us with a customary song

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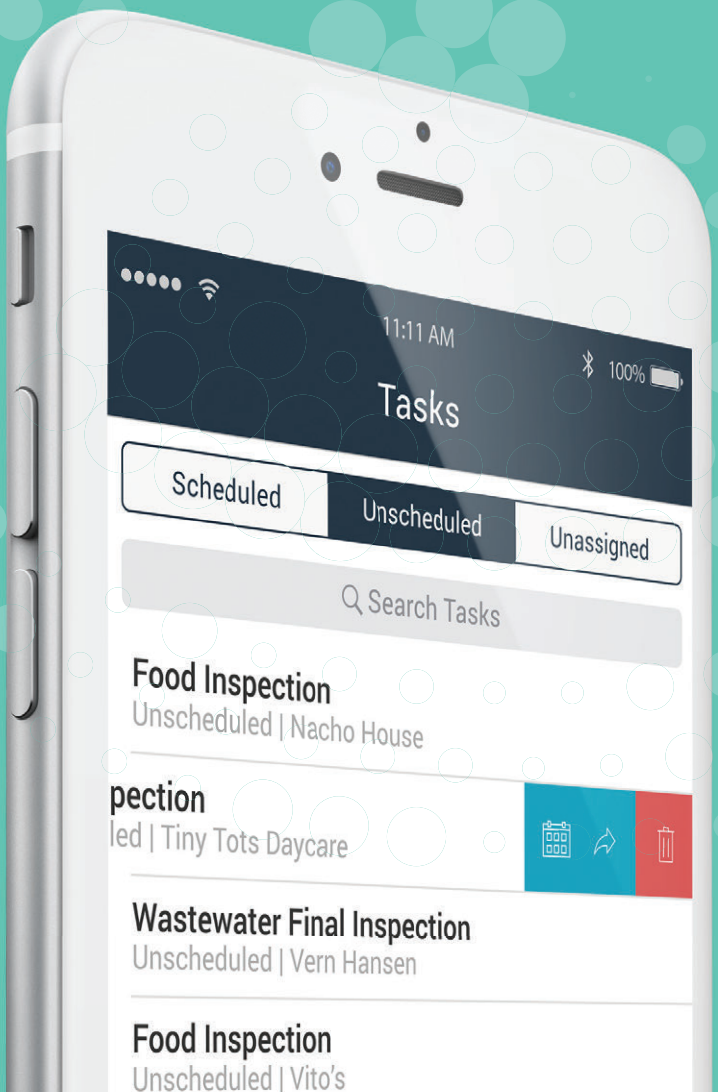

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SPECIAL REPORT

Rural Community Viewpoint on Long-Term Research Participation Within a Uranium Mining Legacy, Grants Mining District, New Mexico

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Abstract **Well-constructed epidemiologic studies provide information about environmental risks and inform interventions and public health policies. Using focus groups, this pilot project examined the attitudes, beliefs, and concerns of rural-dwelling adults toward participating in a longitudinal cohort study. Focus group participants who were 40 years or older, residents in the Grants Mining District, and had no previous diagnosis of diabetes (except gestational diabetes) were recruited from a local physician's office in the Grants Mining District. Participants provided insight into local health concerns, willingness to participate in long-term research and to provide biological specimens, and consent form expectations. For this population, the uranium mining legacy in the Grants Mining District is a contextual factor that can be addressed via community engagement and in the study design to minimize misinterpretation or bias and to maximize the ability to detect causal risk factors for health outcomes.**

Introduction

The three core public health functions (assessment, policy, and assurance) rest upon the foundation of the public health sciences of epidemiology and biostatistics. Well-constructed epidemiologic studies provide information about environmental risks and inform interventions and public health policies. Large, long-term cohort studies focusing on chronic diseases are often the best method to identify excess risk due to specific environmental exposures. One strength of a cohort study is the ability to characterize exposures and risk factors before disease onset, eliminating a bias that may be present with other study designs. Long-term cohort studies, however, require considerable resources and a strong commitment by community members participating in the study. Creating partnerships with the community is a critical step in designing successful epidemiologic research efforts that inform both interventions and policies. Community context is also vital to understanding appropriate and targeted recruitment and data collection methods for a selected community.

This pilot study was part of a planning process to develop a long-term epidemiologic cohort study that would examine exposures and risk factors for chronic diseases in rural communities throughout New Mexico. The state has a unique and diverse population that is approximately 47% Hispanic, 40% non-Hispanic white, 10% American Indian, and 3% other race/ethnicity (U.S. Census Bureau, n.d.). Although New Mexico is culturally rich, it is consistently ranked as one of the 10 poorest states in the U.S. About 30% of residents live in rural areas (U.S. Census Bureau, 1995), often with limited healthcare facilities. Chronic health conditions in New Mexico, such as diabetes, obesity, heart disease, and certain cancers vary widely among racial and ethnic groups. For those with these chronic conditions, racial and ethnic groups other than non-Hispanic whites often have higher mortality (New Mexico Department of Health, 2013).

The purpose of this pilot project was to examine the attitudes, beliefs, and concerns of rural-dwelling adults towards participating in a longitudinal cohort study, and to assess factors that contribute to willingness to participate. Focus groups were held in the Grants Mining District to discuss the possibility of implementing a long-term cohort study with blood samples to study chronic diseases in rural communities throughout New Mexico. The Grants Mining District was chosen for this pilot study because of its rural nature, cultural diversity, and local availability of healthcare providers and facilities, as well as the considerable historical uranium mining activity (Figure 1). Using this community-engaged approach, the research team hoped to gain important information to maximize acceptance of and participation in a future long-term research cohort study.

FIGURE **1**

Jackpile Mine, Laguna Pueblo, New Mexico, July 13, 1958

Context: Grants Mining District, New Mexico

The Grants Mining District (also referred to as the Grants Mineral Belt) is primarily in Cibola and McKinley Counties, but also includes portions of Sandoval and Bernalillo Counties, as well as tribal land, and is located off Interstate 40 between Albuquerque and Gallup. The Grants Mining District was the primary focus of uranium extraction and production activities in New Mexico from the 1950s until the late 1990s. With the decline and eventual end in mining came a rise in unemployment and a decline in the population as many miners and their families left.

There are 97 legacy uranium mines in the Grants Mining District (U.S. Environmental Protection Agency [U.S. EPA], 2011) and a number of mill sites where chemicals were used to extract uranium and make "yellowcake," a powder that can be processed into fuel for nuclear reactors. By-products of milling include a sandy waste containing heavy metals and radioactive radium (U.S. Nuclear Regulatory Commission, 2015). The Jackpile-Paguate mine on the Pueblo of Laguna was once the world's largest open pit uranium mine (Figure 1), and it was placed on the National Priorities List of Superfund sites in December 2013. Assessment of health and environmental impacts of uranium mining and milling in the Grants Mining District continues through multiple agencies such as U.S. EPA, the New Mexico Department of Health, the U.S. Nuclear Regulatory Commission, and the New Mexico Environment Department (U.S. EPA, 2016).

Methods

Focus group participants were recruited from a local physician's office in the Grants Mining District via the use of personal visits, flyers, and advertisements at the clinic. Focus groups were conducted at a local community center. Inclusion criteria were age 40 years or greater, residence in the Grants Mining District, and no previous diagnosis of diabetes (except gestational diabetes during pregnancy). The University of New Mexico Health Sciences Center's Human Research Protections Office approved all aspects of the research protocol.

Two focus group sessions were planned (8 to 12 participants in each), but because only two participants attended the first session, a third session was conducted to reach data saturation and the target sample size of 16 to 20 participants. Each focus group lasted 60 to 90 minutes, including time for informed consent and for participation. Each session was digitally audio recorded. Each participant was given a $50 gift card upon completion of the focus group.

The facilitator presented the goal of obtaining information related to participation in a long-term research study, (i.e., a cohort study). Then the facilitator presented each pre-identified question one at a time and clarified any questions to aid understanding. The questions were semistructured and open-ended to collect qualitative data to inform future research. Questions focused on health problems in their community, feelings about participating in a long-term research study related to health problems, feelings about providing blood samples for long-term research, and expectations for the content of a consent form.

Audio recordings were transcribed verbatim and transcripts were compared to the audio recordings to verify accuracy. Two researchers independently performed the qualitative analysis, and then codes and themes were compared. Guided by the principles of content analysis for qualitative data, the following steps were taken: the data were read several times for familiarity and identifying themes, analytic and grounded categories were established, systematic criteria for sorting data were established, data were sorted into categories, and patterns were identified and considered in light of relevant literature and theory (Stemler, 2001). The two researchers reviewed the data multiple times to identify and crystallize major analytic themes. A content analytic summary reflected the overall themes of the focus groups.

Results

The study population included 13 (46%) males and 15 (54%) females ages 40 to 64 years who resided in the Grants Mining District and had a racial/ethnic distribution of

25% non-Hispanic white, 68% Hispanic, and 7% American Indian. The major summary themes include concerns about environmental contamination and the need for any long-term research study to address these concerns using contextually appropriate research methods. We detail these themes below.

Health Problems in the Community

When asked about health problems in their community, cancer and respiratory issues were major concerns and an environmental link was attributed to both. Cancer was the most significant health concern. Many participants attribute what they perceive as high cancer rates in their community to environmental contamination.

" . . . there's cancer . . . I don't know if it's because of the water. Or the mines."

"I think another health issue that's in [town] is that people don't realize that people develop cancer for some reason . . . most of the time people think that the cancer's related to the uranium activity that was in the area, plus the groundwater . . . "

Another health problem that was often mentioned was asthma and respiratory problems, with participants noting that they perceived an increase in asthma and other respiratory illnesses in recent years.

" . . . there's a lot of lung stuff going on in this area, too. . . . all the kids . . . they all have their inhalers on the bench, all of them."

"The coal mine is nearby, so there's a lot of people with black lung I'm sure. I don't know, but I'm sure there is. I mean c'mon, that's a lot of black dust."

Willingness to Participate in a Long-Term Research Study

When asked about a long-term research study, the majority of participants indicated that they would be receptive to participating in such research, particularly if their participation helped address some of the health concerns within their community and if barriers to participation were addressed.

"I would be fine with it, but is it going to help our community here in town? . . . talking about it and doing it are two different things."

"I'm into finding out new things and seeing new things happen and seeing if they can be resolved and help the community or help the future of health . . . anything helps."

"I do think that generally most people are very passive about [health research] unless it actually hits home . . . they hear about it and they don't get really involved and concerned until someone in their family or somebody close to them is diagnosed . . . "

Participants also described a number of positive actions that would encourage people to join a long-term research study such as education and transparent knowledge transfer about the research, minimizing the research study time commitment, community dissemination of results, and direct health benefits to their community. On the other hand, the lack of privacy was indicated as a barrier to participating in long-term research, and may be more of an issue in this rural area as compared with more urban areas.

"Lack of privacy I guess would be the main [concern] for anybody in here . . . here in [town] everybody knows everybody."

"It's a small town, there's no privacy."

Attitudes Towards Providing and Storing Blood and Biological Specimens for a Research Study

Most participants indicated that they would be willing to provide blood samples for research purposes and that long-term storage of these samples would be acceptable to them. Their willingness, however, was often based on full disclosure of the tests and evaluations conducted on their blood sample.

"I'd be good with that. I'm always giving blood. No problem there."

"I think that most of the people . . . would be good with something like this. They would be open to having blood drawn, for the most part, and having it stored."

" . . . how am I helping by providing a blood sample to this research study? That's what I would want to know."

" . . . as long as I'm informed, I would be fine with that."

A few were hesitant, particularly in regards to the potential risks associated with providing blood samples.

"I think my concern would be if you were taking blood samples and something went wrong and it says that we'll call your doctor for you. If I have insurance, then I'm basically putting myself out there. There's also an element of health risk if there's an infection of blood . . . and something goes wrong with samples, [the cost] is on me."

Consent Form Information

Participants stated that consent forms need to provide details regarding where the study is being conducted, the specific research activities involved, and clear expectations of the research participants. Participants also suggested that the language in the consent form needs to be in layperson terms, to alleviate potential confusion and misunderstanding on the part of participants.

"I would like to know what is going to be involved, if there's going to need to be blood work done. . . . If we're going to be given a placebo as opposed to a real drug . . . I'd like to just know what is going to be involved."

"Layman's [language] . . . Not all these big, long [words] . . . Do I sign or not because I don't know what this is. I don't know what it means."

Additional Wisdom From the Experience

When researchers design a study to determine if there is an association between exposures and outcomes, all variables that may cause misinterpretation or bias in these associations need to be taken into consideration. Therefore, it is critical when performing a long-term cohort study to understand the contextual factors in a community. Our research team learned that the mining legacy in the Grants Mining District is a significant factor in the cultural and health identity of the community. It is natural that the mining legacy will impact the way people think about the connection between the environment and health, regardless of evidence for direction causation. For this population, the mining legacy is a contextual factor that needs to be addressed via community engagement and in the design of the study in order to minimize misinterpretation or bias and to maximize the ability to estimate the true associations of the exposures and outcomes of interest.

As previously mentioned, assessments of health and environmental impact of uranium mining and milling in the Grants Mining District continues to date. Community experience with these assessments resulted in community members who expect clear descriptions of research studies (i.e., they are research savvy). At the same time, they have a strong desire to support their community and want to participate in research that will benefit their

community and lead to sustained improvements in community members' health.

Although the participants were experienced with research efforts in the community, the focus group also revealed that there is not a common understanding of what a cohort study is (i.e., long-term observational study). Although the concept of a cohort study was briefly introduced at the beginning of the focus groups, such a cursory presentation was insufficient for understanding. Almost all participants equated a "cohort study" or "research study" with treatment that "will be done to them" or serial physical measurements in a clinic that would be taken over a limited time period: in other words, a clinical study or an intervention trial. Education about long-term observational studies would be beneficial during study recruitment.

Looking Ahead

Before initiating a long-term cohort study, it is important to engage in discussions with community members to understand contextual factors that will impact perceptions of public health research. Results from this study suggest that a successful research study in such a setting should engage, protect, and enhance the health status or health knowledge of the community. For example, one way to engage the community is to obtain knowledge about the community's health concerns, as was done through focus groups in this study. A successful research study could protect the community through the use of understandable consent forms, efforts to maintain privacy, and transparency about testing and storage plans for biological specimens. The health status or health knowledge of the community could be enhanced by dissemination of research results in the community and through targeted messaging to help people understand factors impacting their health. In this community and similar communities, the potential health impacts of the mining legacy need to be addressed because they shape the perceptions of individual and group health status in the community. Querying participants about their residential history, occupational history, relevant environmental exposures, and perceived influences of these exposures on health status would provide vital exposure and confounding information for understanding causal linkages to disease in this community. In this manner, a contextually relevant analysis can be done.

Long-term studies require a commitment from both researchers and community members. Working with the community as partners creates mutual benefits. The community represented in this study supports sustained changes in their community through research and research projects, and in situations like this active participation of the community in the research would be desirable. For example, given appropriate training, community members could either volunteer or be employed as spokespersons, research assistants, community health workers, or recruiters. Additionally, community members can participate in a community advisory board for the research and have a voice in all aspects of the research. Successful research efforts need to embrace the community members as partners, taking into account the legacy and experiences of the people, and create a mutually beneficial partnership to increase healthy outcomes.

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