From the Schools of Public Health

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On Linkages

COMMUNITY-BASED PARTICIPATORY RESEARCH AND THE ESCUELA DE SALUD PÚBLICA IN MEXICO

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For a number of decades, some community studies and interventions have been designed according to parameters, criteria, and perspectives, without taking into consideration the population.[1] Recent studies in communities in the United States, Canada, and Australia have shown the great value of participatory research, where the researchers, community authorities, and population are equally involved, thus improving public health research and community interventions.[2–5] These programs, which include community training, are of significant importance for students wishing to learn more about a range of environmental, social, and economic factors that affect health in all societies.[6,7]

Medical schools worldwide are including programs whereby students conduct practical work outside the classroom and teaching hospitals (e.g., rural placement programs in Tasmania and the West Virginia Rural Health Education Partnerships). Community medical education offers students the opportunity to learn about the needs of people in communities, which contributes to the students' education[8,9] and helps train doctors who will work in these communities in the future.[6,10–12]

Close collaboration among the research team, the population, and the decision makers who are responsible for setting public health policies, sustaining future public health, and promoting health is indispensable in community-based research.[13–15] Community-based participatory research (CBPR) represents a focal point for research and evaluation that is receiving attention in the public health field. CBPR reinforces many of the basic tenets of public health as a science dedicated to the improvement of health and to the well-being of communities and individuals. Diverse institutions including The Committee on Educating Public Health Professionals for the 21st Century, the University of British Columbia, and the Canadian Institutes of Health Research have indicated CBPR as a focal point for community development.[16,17]

This article describes the impact of three community-based training courses that form part of the curriculum of the master's in public health (MPH) program at the Escuela de Salud Pública de México (School of Public Health of Mexico), which is part of the Instituto Nacional de Salud Pública (National Institute of Public Health) in Morelos, Mexico.

COURSE DESCRIPTION

In the MPH program at the Instituto Nacional de Salud Pública, there are three courses relating to community learning: Learning Based on the Community I, II, and III. These courses focus on the theory and methodology of community diagnosis and the evaluation of population health needs and community interventions to solve health-disease problems, manage health diagnoses, and design and evaluate community interventions. These three courses are imparted in succession and during different terms.

The first course focuses on community health, how to establish adequate communication with the population, and the methodological theory for community diagnosis. The second course teaches methods for prioritizing health problems. The third course analyzes the design and evaluation of community interventions, with the objective that the students design programs that attempt to provide solutions to the problems emerging from the health diagnosis.

Public health practice occurs within a sociocultural context and involves all the complexities that affect populations. These experiences, therefore, give future public health professionals an opportunity to link theory with practice, strengthen their perspectives, promote discussion, and hone decision-making skills.

Articles for *From the Schools of Public Health* highlight practice- and academic-based activities at the schools. To submit an article, faculty should send a short abstract (50–100 words) via e-mail to Allison Foster, ASPH Deputy Executive Director, at afoster@asph.org.

The students participate in multidisciplinary teams with other students and professors from the school. The Mexican municipality of Yautepec, Morelos, was selected in conformity with the inter-institutional agreements that the Instituto Nacional de Salud Pública has with the Health Service of Morelos. The decision to work in the community of La Nopalera, which is situated within the municipality of Yautepec, was made jointly by the team of students, their professors, and the sanitation and municipal authorities. This locale was selected because it is extremely marginalized, has no infrastructure for health services, lacks public services, and has limited geographical access.

The team established links with civil and community organizations in La Nopalera with the aim of promoting the community's active participation in community diagnosis and evaluation of health needs. The team visited once or twice a week during the 15-month study period to conduct community diagnosis and community interventions. During this time, they became involved in the daily lives of the population, which allowed authorities and community organizations to get to know each other and develop trust in the team members.

The team collected, analyzed, and synthesized the sociodemographic and health-disease characteristics of the population. Then they prepared and presented the results of the community diagnosis within the community as well as to civil authorities and the municipal health service. Following community diagnosis and based on the health needs assessment, the students and their professors designed programs and community interventions, which were analyzed and discussed with authorities and community organizations to provide relevant solutions.

COMMUNITY DESCRIPTION

La Nopalera, located in the central-southern part of the state of Morelos, is a rural community with 600 inhabitants, comprising a youthful population with high fertility levels. Seventy percent of families are of low socioeconomic status. The principal occupation is agriculture, which is conducted on a seasonal basis. Temporary land use is the name given to areas that are irrigated with rainfall. If rain is insufficient, the harvest is lost. Only 5.6% of the population has access to social security, and the mean annual expenditure on health per family is $722.50.[18]

This community is considered to be very marginalized because it has no running water, health service, or garbage collection, and road surfaces and drainage are inadequate. La Nopalera also produces pork, which causes environmental contamination.[19]

METHODS

The students formulated a research project to plan activities for community diagnosis,[20] which was conducted focusing on CBPR. The research project was presented to civil and health authorities of the municipality. The community of La Nopalera was chosen with the intention of teaching the students how to make a community diagnosis with the population's active participation.

The team of students, under the supervision of their professors, initiated contact with the various community organizations within La Nopalera: *ejido* owners (*ejidos* are agricultural production cooperatives in which members equally own machinery, tools, and farmlands for growing and harvesting goods for either personal consumption or profit), women's health service groups, religious groups, schoolteachers, students at primary and secondary levels, and mothers and fathers of families. For each of these groups, a session was held using a pamphlet designed by the students to explain what a community diagnosis consists of and the importance of population participation. Subsequently, social cartography exercises were undertaken in which the various groups were required to identify the risks and strengths of the community on a map that the students had drawn.[21] The students also conducted a census (n=170 households) permitting personal encounters with each of the families, with the aim of inviting them to a meeting where they could participate in identifying the community's problems and needs. Activities for children, teenagers, and adults were planned for these meetings.

Community problems were prioritized with the participation of the population using the modified Hanlon method. The modified Hanlon method consists of convening the entire population along with civil authorities to participate in a community meeting to identify problems affecting the community.[22] Twelve mixed groups of men and women were formed, consisting of 10 participants in each group. A total of three meetings took place: the first meeting identified the community's needs and problems, the second prioritized the needs and problems, and the third analyzed the link between the prioritized problems and social factors.

At the first meeting, the groups identified 29 problems. At the second meeting, these problems were analyzed, with community members giving their points of view in terms of the four components of the

Hanlon method: magnitude, severity, effectiveness, and feasibility.[22] At the third meeting, with community participation, problems that could be approached as community interventions were selected.

Members of the population indicated two problems that could be resolved through collective action: (*1*) garbage and environmental contamination and (*2*) lack of opportunities for young people to either further their education or find jobs. The creation of community youth groups would help combat the observed increase in alcohol consumption and other addictions by providing activities for this population subgroup.

The results of the community diagnosis of priority problems were presented to the entire population, as well as to civil and sanitary authorities. The team of students and professors responsible for designing strategies to combat these problems included several proposals for community intervention, a concept that was also explained to the population. As a result, both the local people and the authorities approved implementation of the proposed community intervention projects. Community interventions were directed toward projects with young people, waste management, environmental contamination, and families' health expenses. The students worked with young people (mean age = 16 years) of both genders to promote personal resilience and impart sexual education.

One of the interventions focused specifically on garbage disposal, with the student team proposing the separation of organic waste to convert into compost and the creation of a collection center where inorganic waste could be deposited. To establish the collection center, a community committee was formed in which men and women were trained in environmental themes and concerning the separation of waste. The local committee and the young people, with assessment from students and professors, have taken responsibility for a variety of activities, including collecting funds for the construction of the collection center and participating in legal activities together with local, municipal, and state authorities to find a physical space and financial resources to support the project.

A further intervention focused on pork farming, specifically the biological control of flies, to diminish environmental contamination.

RESULTS

Almost 40% of the population participated in the various activities for the community diagnosis and continued to participate in an active way in the interventions. Meeting attendance was recorded so that the percentage of the population that participated could be determined. The community interventions were structured with an integral vision, meaning that the implemented solutions combated a variety of health problems and involved participation from a range of population subgroups.

The garbage disposal problem was confronted with the aim of training a number of groups to be responsible for separating waste products. Adults, teenagers, and children were all equally involved in this activity. The population took the first steps toward constructing a storage center, which would be used to store and commercialize waste products, as well as organizing procedures for composting organic waste. Teenagers, with support from adults and teachers, will be responsible for managing the collection center.

The students and professors gave direction for a community garbage disposal project to a group of adults aged 30–45 years. The group sent a proposal to the Ministry of the Environment and Natural Resources requesting financial support for building the collection center and separating waste in the community. This group is also implementing processes to improve pig farming in the community.

To reinforce activities involving children and teenagers, a group of women from the church, with the help of students and teachers from the Escuela de Salud Pública de México, requested funding from the National Council for Culture and Arts to support music classes for children and teenagers from the area. Musical instruments have now been acquired and two teachers come every week to give music lessons.

A study of expenses for preventive health, the local health center, and hospital care was also conducted together with the families in La Nopalera. This report was presented to sanitary authorities to consider when planning the region's health services (Figure).

DISCUSSION

Practical experience within the community permitted students to use the theory disseminated in the courses of the MPH program to tackle real-world challenges and expand their experience. The students evaluated the course, the community practice, and the teamwork. Comments included:

> Learning was very effective. Now it's very clear to me that community work should always involve the participation of the population, as this motivates the implementation of diverse activities, initiates a debate, creates critical consciousness, and above all is constructive. Working in a team with my colleagues was a very positive experience.

Figure. Outcomes of a health diagnosis and community intervention in La Nopalera, Morelos, Mexico: 2007–2008

Aspect	*Outcomes following community diagnosis and community interventions*
Population and environment	(a) Population made aware of need for garbage separation (b) 30% of families separate their garbage (c) Community group trained in separation of garbage and management of inorganic garbage collection center (d) Community group formed to manage garbage and take care of environment (e) Community group formed to interact with civil authorities to find solution to garbage problem (f) Schoolteachers participate in project for garbage separation (g) Assessment of waste from pig farming and viable proposals for their management and adequate disposal (h) 69% reduction in adult flies related to pig farming
Group of adult women	(a) Formation of women's group to manage resources for activities involving children and young people (b) Women presented project to obtain resources from the National Council for Culture and Arts to buy musical instruments (c) Women's group formed to manage resources for music group comprising children and young people
Group of children and young people	(a) Young people trained in reproductive health with a gender perspective (b) Secondary school students trained in garbage management and about flies acting as vectors, consequently contaminating food and causing health problems (c) Children and young people made aware of need to separate garbage (d) Children and young people attend music classes and have formed a band
Information on health and population services	(a) Information for the population concerning health expenses (e.g., preventive care and medicine for families in the locality) (b) Information for the population concerning emergency expenses

Source: Arenas-Monreal L, Cortez-Lugo M, Parada-Toro I, Cervín-Garcia E, Pacheco Magaña LE, Espinoza-Cardenas F, et al. Community diagnosis and community interventions. Mexico. 2008–2010.

> Community practice broadened my horizons. A person is part of a community, of a culture with a customary way of living, and here a number of social determinants take effect, which need to be analyzed and modified if there is to be any real improvement in health.

The students indicated that within public health, a link between theory and practice is essential and that this course reinforced this premise:

> It is essential that community work for a health worker in the public health service should not just consist [of] learning theory, but that community practice should be obligatory. This involves contact with the population and the realization that lack of employment, education, opportunities, poor housing conditions, an unhealthy environment, inequality, and social injustice are aspects influencing health and that public health is not only related to the health sector.

Through these courses of community practice, the students acquired an ethical obligation to work for the population, and as health workers, they understood the need to reduce inequality, which afflicts the population. With this experience, it also becomes evident that public health is not solely the responsibility of the health sector, and that in working with the population, it is necessary to have an integral focus to diminish inequalities because health is related to social justice.[23]

It is currently necessary for the professors from the Escuela de Salud Pública de México to continue to provide guidance to the various local groups to manage the resources obtained for the community (e.g., resources needed to support the music group), as well as to advise on how to manage the various federal and municipal institutions to solve the problems revealed in the community diagnosis. It is also imperative that the civil authorities in the community and the municipality be committed to the projects that the population has initiated and provide support to ensure that these initiatives continue.

CONCLUSIONS

The curriculae of the MPH program at the Escuela de Salud Pública de México includes a link among students, teachers, the community, and authorities contributing to a greater understanding of the factors determining health and the socioeconomic, cultural, and political context in which the population lives. The bonds among the students, community, and authorities

represent the key to improving the relevance, sustainability, and effectiveness of community programs in public health.[24]

In this project, closeness to the community, through a focus on CBPR, was of paramount importance, as the population participated in identifying their own problems and finding solutions. Moreover, this outreach has helped in such a way that the community interventions initiated by the team of students have been assumed by the diverse population groups, to some extent improving the health and living conditions of the population.

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Student Column

AN INNOVATIVE PUBLIC HEALTH PREPAREDNESS TRAINING PROGRAM FOR GRADUATE STUDENTS

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The heightened perception of risk of emerging infectious diseases; natural disasters; and biological, chemical, and radiological terrorism has brought much attention to the urgency of strengthening the nation's public health preparedness and response infrastructure. Training activities have been mainly focused on increasing the capacity of primary responders, particularly in the emergency management, fire, and police forces.[1] Trainings such as basic disaster life support, advanced disaster life support, and incident command structure focus on addressing immediate post-disaster needs. Less attention has been given to training of "secondary" public health responders, including those responsible for post-disaster damage and needs assessment, response evaluation, and disease surveillance activities. As a result, it has inhibited the complete integration of public health within the emergency management structure. While emergency response trainings exist for public health professionals, they often overlook the importance of enhancing the fundamental public health role in emergency situations.[1]

Centers for Disease Control and Prevention-funded Academic Centers for Public Health Preparedness (A-CPHPs) have been established at academic public health institutions around the nation to better incorporate public health professionals within the emergency response community and support the role of academia within the local response network.[1–3] A-CPHP trainings are primarily geared toward developing the preparedness and response capacity of the current public health workforce, through competency-based trainings at state health departments and local health departments (LHDs).[4–6] While this approach assists the current public health workforce in meeting standard readiness competencies, it does not address the need to prepare the upcoming generation of public health workers. Academic institutions are gradually adopting this endeavor by introducing public health preparedness within their curriculum, through certificate programs and special courses.[2,4] However, there remains a need for a skills component to integrate theory and practice within academic programs.

Graduate student epidemiology response programs (GSERPs) provide a venue for integrating skills-based components within academic programs. GSERPs are student organizations that assist local public health agencies by providing academic expertise and volunteers to expand the capacity for responding to infectious disease outbreaks, natural disasters, and other emergencies (i.e., surge capacity). GSERPs at schools of public health around the nation have training structures in place to prepare their volunteers to fulfill health department needs.[7] Most GSERPs offer courses in basic skills, such as confidentiality, outbreak investigation, and interviewing.[8,9] These courses are conducted using a variety of methods, including online, classroom-based, and just-in-time trainings at the LHDs immediately prior to launching a response.

The Student Epidemic Intelligence Society (SEIS) at The University of Texas School of Public Health (UTSPH) is the first GSERP to offer a training program in the core areas of public health preparedness.[10] This article describes the SEIS Public Health Preparedness Training Program (PHPTP) and discusses how GSERPs serve as an ideal mechanism for delivering skills-based training for students while preparing them to meet the emergency response needs of local public health agencies.

THE PUBLIC HEALTH PREPAREDNESS TRAINING PROGRAM

The SEIS is a student organization created in 2003 with the objectives of (*1*) providing emergency assistance to health departments during infectious disease outbreaks and other public health emergencies, (*2*) offering students didactic training and hands-on field experience in outbreak and disaster preparedness and response, and (*3*) developing competency in emergency operations management.[10] The SEIS has assisted LHDs with numerous infectious disease outbreak investigations, community needs assessments, post-hurricane damage assessments, and post-hurricane syndromic surveillance activities to detect infectious disease outbreaks in emergency shelters. The response operations of the SEIS have been described elsewhere.[11,12] Since its inception, the SEIS has prepared students for their volunteer work with LHDs through basic trainings in confidentiality and outbreak investigation. However, the increasing demand for SEIS support from the LHDs demonstrated that both students and health depart-

ments would benefit from a more diverse and comprehensive training program. To meet this demand, the SEIS formalized its trainings by creating the PHPTP, which was launched in the fall of 2008.

The elected student officers of the SEIS developed the PHPTP curriculum. Officers first identified public health skills that would be useful for serving the immediate needs of the health departments and preparing students for future public health practice. Officers then solicited recommendations from UTSPH faculty, who helped align the content of the PHPTP with the Applied Epidemiology Competencies outlined by the Association of Schools of Public Health.[13] From this content, 10 training modules were developed to address the identified skills. The trainings are delivered as classroom lectures, hands-on exercises, and/or field-based trainings (Figure).

Classroom-based modules

Classroom-based lectures include Outbreak Investigation, Confidentiality, and History and Consequences of Bioterrorism. Development of hands-on components to these modules is underway, including a tabletop exercise for the Outbreak Investigation module. This exercise will depict an infectious disease outbreak scenario that requires participants to establish a case definition; prepare for fieldwork; collect, orient, and analyze data; initiate surveillance; identify appropriate public health interventions; and communicate findings.

Hands-on modules

Existing trainings with hands-on components include Overview of EpiInfo™ epidemiologic software, Risk Communication, Emergency Operations Management, Electronic Data Collection (Day 1), and Expanded Program in Immunization (EPI) Cluster Sampling (Day 1). The first day of the EPI Cluster Sampling module provides an example of the integration of a hands-on component into the PHPTP. In this module, students use electronic U.S. Census data to create a sampling frame and generate a random walk-in preparation for a mock survey on Day 2.

Field-based modules

Trainings with a field-based component include Mass Screening, EPI Cluster Sampling (Day 2), Electronic Data Collection (Day 2), and Physical Readiness. On the second day of the EPI Cluster Sampling module, participants conduct a mock environmental survey using the sampling procedures and random walk designed on Day 1.

PHPTP leadership and evaluation

PHPTP trainings are led by UTSPH faculty from the divisions of Epidemiology, Management and Policy, and Environmental and Occupational Health who generously volunteer their time and expertise. The trainings are conducted on a monthly basis during the academic year and are scheduled based on the availability of instructors. The SEIS student officers serve as the coordinating body for the PHPTP. They are responsible for assisting instructors in the development and delivery of the modules, scheduling trainings, preparing materials, and other logistics, including advertising, set-up, and transportation for events. Officers are also responsible for conducting evaluations of the PHPTP. Individual PHPTP modules are evaluated by administering a 10-question pre- and post-training test to participants; comparison of the scores assesses improvement in understanding the principal lessons from each training module.

The SEIS student officers maintain a database of each member's completion of PHPTP modules. Although completion of all PHPTP modules is not a requirement for participating in the SEIS's response activities, LHD partners occasionally ask for volunteers with specific skills. In these cases, SEIS members who have completed the relevant training module(s) are contacted and invited to volunteer in the response.

DISCUSSION

The SEIS PHPTP is a novel approach to integrating skills-based training into public health education. Rather than focusing on the skills required of primary responders in emergencies, the PHPTP modules specifically target the fundamental roles of public health workers, including post-disaster damage and needs assessment, response evaluation, and disease surveillance. The modules combine classroom lectures, hands-on exercises, and field-based trainings to appeal to a broad spectrum of learning styles. While the PHPTP is structured around 10 modules, the program can easily accommodate additional trainings as needed. For example, a Disease Surveillance training module was incorporated into the PHPTP curriculum during the 2010–2011 academic year. Additionally, the program is coordinated by elected student officers and taught by faculty volunteers, making it an inexpensive and sustainable option in an academic environment with high demand for limited funds.

Conducted within the framework of a GSERP, the PHPTP model developed by the SEIS offers an option for providing skills-based training outside the core public health curriculum. While the SEIS operates as

Figure. Description of the UTSPH SEIS Public Health Preparedness Training Program's classroom-based, hands-on, and field-based training modules and their respective Applied Epidemiology Competencies[a]

Training module	*Description*	*Applied Epidemiology Competencies[a]*
Classroom-based		
Outbreak investigation	Training on outbreak investigation procedures, including defining an epidemic; preparing for fieldwork; collecting, orienting, and analyzing data; initiating surveillance; and communicating findings	A1. Recognize the existence of a public health problem B2. Identify surveillance data needs B3. Implement new or existing surveillance systems C3. Characterize investigative processes for identifying acute and chronic conditions or other adverse outcomes in the population C4. Create hypotheses C5. Assist in design of investigation C6. Conduct investigation as directed
Confidentiality	Lecture on confidentiality and protection of human subjects; mandatory for SEIS members who participate in outbreak response activities with a local health agency	D1. Follow ethics guidelines and principles when planning studies; conducting research; and collecting, disseminating, and using data D2. Apply relevant laws to data collection, management, dissemination, and use of data and information D4. Describe human subjects research
History and consequences of bioterrorism	Lecture that provides an overview of the history of bioterrorism, development of the select agents and toxins group, facilities design, laboratory risk assessment, and the principles of laboratory biosafety	NA
Hands-on		
Rapid assessment methods: EPI cluster sampling (Day 1)	Exercise to teach the procedures used in the EPI cluster sampling design (including use of electronic census data, population-proportional-to-size methodology, and random walk procedures) in preparation for a mock environmental survey on Day 2	C6. Conduct investigation to identify acute and chronic conditions of other adverse outcomes in the population (using identified sampling methods)
Overview of EpiInfo[b]	Computer-based exercise to teach the basics of creating and maintaining a database and analyzing data using EpiInfo	E1. Assist in definition of database requirement F1. Use analysis plan for data for an epidemiologic investigation F2. Conduct data analysis
Risk communication	Exercise that teaches a concise strategy for preparing messages during emergencies to avoid mixed messages and confusion between officials and the public	B3. Implement new or existing surveillance systems (maintain good working relationships with reporting entities; provide feedback to reporting entities and other organizations or individuals who need to know about data or the system) B4. Report key findings from surveillance systems
Emergency operations management	Tabletop exercise to familiarize participants with the incident command structure used to coordinate response efforts during public health emergencies	NA
Electronic data collection (Day 1)	Computer-based exercise to teach the basics of designing and utilizing an electronic questionnaire for collecting survey data	C6. Conduct investigation to identify acute and chronic conditions of other adverse outcomes in the population (using data collection instruments that have been constructed for an investigation)

continued on p. 444

Figure (continued). Description of the UTSPH SEIS Public Health Preparedness Training Program's classroom-based, hands-on, and field-based training modules and their respective Applied Epidemiology Competenciesa

Training module	*Description*	*Applied Epidemiology Competencies*[a]
Field-based		
Mass screening	Drill to practice procedures for mass screening in response to a hypothetical multisite radiological attack	C1. Assist in conducting a community health status assessment
Rapid assessment methods: EPI cluster sampling (Day 2)	Mock environmental survey using the sampling procedures and random walk designed on Day 1	C1. Assist in conducting a community health status assessment
Electronic data collection (Day 2)	Mock interviews using handheld computers and the electronic questionnaire developed on Day 1	B3. Implement new or existing surveillance systems (interviewing people with illness to solicit necessary information)
Physical readiness	Biweekly fitness session based on the physical fitness criteria of the U.S. Public Health Service (including a 1.5-mile run, push-ups, sit-ups, and side bridges). The program culminates with a drill at the family-oriented UTSPH Annual Public Health Field Day	NA

[a]Association of Schools of Public Health. Applied epidemiology competencies curriculum and practicum project. Washington: ASPH; 2008.

[b]Centers for Disease Control and Prevention (US). EpiInfo™: Version 3.5. Atlanta: CDC; 2008.

UTSPH = University of Texas School of Public Health

SEIS = Student Epidemic Intelligence Society

NA = not applicable

EPI = Expanded Program on Immunizations

a student-run program within a CDC-funded A-CPHP, GSERPs may also operate within the structure of a faculty-guided course or as a program administered by a school, academic division, or center within an academic institution.[7]

Challenges of the SEIS

In the experience of the SEIS, student leadership over the PHPTP is one of the program's most valuable components. It grants student officers the opportunity to gain experience in developing and executing an educational program. However, student leadership also poses challenges for the program's continuity and implementation. Student officers are elected annually, leading to regular turnover in the organization's leadership and management of program operations. The SEIS has been able to address this problem through the election of a number of doctorate in philosophy students who have served on the board for several years, the involvement of a faculty sponsor who is available to guide incoming officers in the operations of the PHPTP, and the establishment of an SEIS-dedicated e-mail address and a central electronic repository for organizational records and program materials. Long-term continuity of the program will require further efforts to document program components to facilitate the transfer of program operations into the hands of future leadership.

Another challenge encountered by the SEIS is the current lack of a thorough systematic program evaluation. Training programs, such as the PHPTP, require robust evaluation to ensure effectiveness of the delivery methods and training materials, as well as to provide data that can be used to apply for funding. However, evaluation of the PHPTP has been difficult due to limited financial resources and time constraints, given the other responsibilities of student officers. A redirection of time and resources may be necessary to give priority to systematic program evaluation.

Despite these challenges, implementing the PHPTP within the mechanism of a GSERP is invaluable in that it offers students the unique opportunity to immediately apply their newly acquired skills by engaging in volunteer response work at LHDs. These opportunities allow students to understand the intrinsic roles of public health professionals within emergency response operations.

CONCLUSIONS

The primary function of a GSERP is to provide surge capacity for secondary response during emergency situations. Given their backgrounds, public health students are an obvious, yet largely untapped resource for fulfilling the manpower needs of LHDs. Health departments would additionally benefit from students who not only understand the fundamentals of public health, but who are also capable of applying these fundamentals (e.g., using assessment, evaluation, and surveillance skills) in real-world settings. Student volunteers who are well-equipped with skills-based training are able to begin work on short notice and contribute valuable expertise during emergency response operations.

Training students while they are housed within an academic institution reduces the need to provide supplementary training in applied public health once they enter the workforce. For this reason, it is important that training programs remain aware of the evolving skills expected of health departments, as the scope of their role in emergency preparedness expands. Relationships between GSERPs and LHDs facilitate a system of regular feedback to adapt the academic training of public health students to meet the current needs of public health systems. This feedback reinforces the position of GSERPs as a crucial bridge between academia and applied public health. By supporting GSERP skills-based training programs for students and response volunteers, academic institutions can strengthen their ability to meet the emergency response needs of local public health agencies while preparing their students for public health practice.

Further information on the PHPTP is available at www.sph.uth.tmc.edu. Training materials are available upon request by contacting the SEIS officers at seis@uth.tmc.edu.

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Student Column

EVALUATION OF DEER-TARGETED INTERVENTIONS ON LYME DISEASE INCIDENCE IN CONNECTICUT

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Lyme disease (LD) is the most commonly reported vector-borne disease in the United States. Between 2003 and 2005, 64,328 cases of LD were reported in the U.S. Of those cases, 93% were reported from 10 endemic states: Connecticut, Delaware, Maryland, Massachusetts, Minnesota, New Jersey, New York, Pennsylvania, Rhode Island, and Wisconsin.[1] In Connecticut, 1,810 reported cases met the surveillance case definition of LD in 2005, resulting in an incidence rate of 53 per 100,000 population.[2]

Reducing the number of blacklegged ticks (*Ixodes scapularis*), the vector for LD should in theory reduce the incidence of LD in an endemic area. One such strategy targets white-tailed deer (*Odocoileus virginianus*). Although deer are not competent reservoir hosts for the LD causative agent, *Borrelia burgdorferi*, they are the primary hosts for adult blacklegged ticks and are an important tick transport mechanism.[3,4] One study showed that more than 95% of adult female ticks feed on white-tailed deer.[5] Nymphal ticks will also feed on deer.[6,7] Therefore, deer-targeted interventions could provide a large-scale method for controlling tick populations by reducing the number and movement of blacklegged ticks. Two proposed deer-targeted interventions have included a topical acaricide applied using a four-poster device and deer-reduction programs. However, few studies have evaluated whether deer-targeted interventions resulted in decreased LD incidence, particularly in non-island settings.

The four-poster device is a passive topical treatment system developed by the U.S. Department of Agriculture, Agricultural Research Services. A central bin stores and dispenses bait to attract deer. As the deer feeds, rollers apply an acaricide directly to the head, ears, and neck, which is transferred to other body areas by self-grooming.[8] Studies of this device have shown a significant decrease in blacklegged tick abundance on deer and in the surrounding area.[8–11]

In 1997, the Northeast Area Tick Control Project (NEATCP) was launched in five states (Rhode Island, Connecticut, New York, New Jersey, and Maryland) to evaluate the effectiveness of the four-poster treatment devices in controlling ticks.[12] Core treatment areas

(CTAs) were approximately 25 kilometers squared (km^2) each, and the four-poster devices were to be deployed at a rate of 25 devices per CTA (or approximately one device/0.2 km^2). This calculation was based on pretrial populations of approximately 44 deer in a CTA, though this number varied slightly with locality.[12,13] The CTA that served as the basis for this rate was located in Old Lyme, Connecticut, where 24 devices were maintained from 1997 to 2002. Tick abundance was monitored at all sites for two years following the removal of the four-poster devices.[14] However, the effect on LD incidence was not evaluated at any of the NEATCP sites.

Another deer-targeted intervention aims to reduce deer populations through a controlled deer hunt. Two studies showed that complete, or near complete, elimination of deer was effective in reducing tick populations on an inhabited peninsula and islands off the northeastern U.S. coast. However, it is unclear whether deer-reduction strategies will translate to mainland settings where deer cannot be eliminated completely.[15,16] Computer simulations have suggested that reducing deer density to 7.5 deer/km^2 could decrease infected nymphal tick density by 40% within four years, while near elimination of deer is needed to lower infected nymphal tick density by >99%.[17] However, it is unclear to what extent deer numbers must be reduced to significantly impact LD incidence, especially in mainland settings.

In 2000, an annual controlled deer hunt began in the coastal Mumford Cove community of Groton, Connecticut. The herd was initially reduced by 92%, and has subsequently been maintained at the same low level, approximately 3.8 deer/km^2.[18,19] A community survey identified a large decrease in self-reported LD cases one year after the initial hunt.[18] However, self-reported data have various inherent limitations.

We evaluated two deer-targeted tick-control strategies for their effects on LD in southeastern Connecticut: four-poster acaricide treatment and deer reduction in a non-island setting. This study aimed to determine if deer-targeted interventions had a significant effect on LD incidence (*1*) before and after treatment and (*2*) in treatment areas vs. control regions.

METHODS

Study area

The study area is depicted in Figure 1. The 25 km^2 four-poster original treatment area was based on the Connecticut NEATCP protocol's CTA and encompassed a portion of the towns of Old Lyme and East Lyme. For the purposes of this study, the original control area comprised the remaining areas of Old Lyme and East Lyme as well as Old Saybrook, which was the NEATCP tick sampling control area.[12] The five towns of Clinton, Deep River, East Haddam, Haddam, and Killingworth were selected as expanded control towns to provide an additional measure of control. Due to their close proximity to the original treatment and original control areas, these towns would be expected to have a similar tick exposure risk.

The deer hunt original treatment area was the community of Mumford Cove, a residential community of approximately 112 homes located on a 1.9 km^2 peninsula along the Connecticut coast in New London County in Groton.[18,20] Mumford Cove has approximately 0.38 km^2 residential development and 41 km^2 woodland area. The remainder of Groton served as the original control area. The nearby town of Stonington served as the expanded control town.

Case data

We identified cases from Connecticut Department of Public Health (CT DPH) LD surveillance records. For the purposes of this evaluation, we defined a case as a resident in the study area who had a physician-diagnosed erythema migrans (EM) rash ≥5 centimeters, and an onset date during the years 1992–2006. EM rash cases were used as a surrogate for incident LD cases.

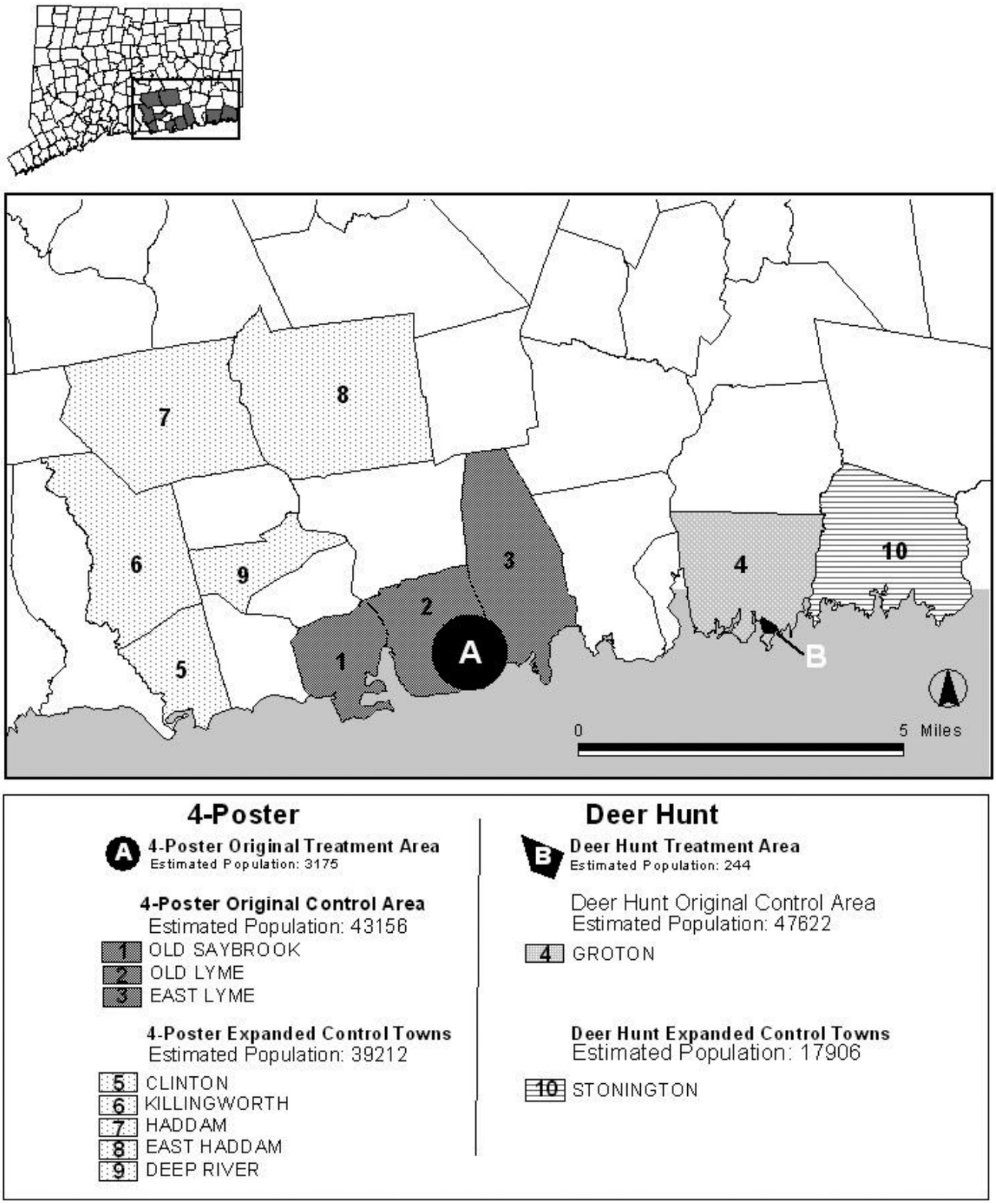
Case addresses were geocoded for classification into original treatment or original control area using ArcGIS® software.[21] We obtained town boundaries and Topologically Integrated Geographic Encoding and Referencing (TIGER) system road data from the University of Connecticut Map and Geographic Information Center.[22] We excluded post office boxes and missing or incomplete street addresses. We did not geocode addresses from cases in the expanded control towns; these cases were assigned to their respective towns.

Data analysis

We obtained U.S. Census block 2000 population data from ESRI®.[23] Census block data were overlaid with original treatment and original control areas using ArcGIS. We calculated incidence as total EM rash cases per 100,000 population for every study year in each area.

To examine the effect of each intervention, we designated a "before treatment" and "after treatment" period. Due to the two-year tick lifecycle, the interventions would not be expected to significantly affect tick populations and disease incidence until two years after implementation. For the four-poster analysis, we classified "before treatment" as 1992–1998 and "after

Figure 1. Connecticut catchment area for a deer-targeted intervention study, 1992–2006



treatment" as 1999–2006. For the deer hunt analysis, we classified "before treatment" as 1992–2001 and "after treatment" as 2002–2006.

We analyzed the data using SAS® version 9.1.3.[24] For both the four-poster and deer hunt original treatment areas, we compared the mean EM rash incidences before and after treatment to determine if the treatment produced a statistically significant difference. We used a student's t-test to analyze normal data. We analyzed non-normal data that could not be transformed using the Wilcoxon Rank Sum test.

To account for the general decreasing trend in EM rash incidence in the study area since 1992,[25] we also compared the EM rash incidence in the original treatment areas with the incidence in both the original control areas and expanded control towns. For each study year, we calculated the relative rate of original treatment area incidence vs. original control area incidence, and the relative rate of original treatment area incidence vs. expanded control town incidence. We then compared the mean relative rates before and after treatment using the statistical tests previously described. This study was approved by the Human Investigation Committees at both the Yale University School of Medicine and CT DPH.

RESULTS

Between 1992 and 2006, 1,296 EM rash cases were reported from the original treatment and original control areas; 212 reports (16%) had missing addresses, incomplete addresses, or post office boxes. Of the remaining 1,084 cases, 943 (87%) were automatically geocoded and 83 (8%) were interactively geocoded. Upon inspection, 50 (4.6%) were outside their respective catchment areas and, thus, excluded. Of the 976 geocoded cases, 702 (72%) cases were in the four-poster areas and 274 (28%) cases were in the deer hunt areas. The median age of cases was 39 years in the four-poster original treatment area (range: 1–82 years); 36 years in the four-poster original control area (range: one day to 86 years); 47 years in the deer hunt original treatment area (range: 3–64 years); and 38 years in the deer hunt original control area (range: seven months to 92 years). During the study period, 1,356 EM rash cases were reported in the expanded control towns: 956 (71%) in four-poster expanded control towns and 400 (29%) in the deer hunt expanded control town. The estimated population for each study area is shown in Figure 1.

Four-poster

The results of the four-poster analysis showed a general decreasing trend in EM rash incidence in all areas (Figure 2). The annual number of cases and the relative rates of EM rash incidence between the original treatment area and original control area, and the original treatment area and expanded control towns are shown in Table 1. In the original treatment area, the mean incidence before treatment was 427.5 cases per 100,000 population (standard deviation [SD] = 94.2); after treatment, the mean incidence was 137.8 cases per 100,000 population (SD=80.6). The mean incidence was significantly different before and after treatment ($t=6.35$, $p<0.001$). The mean relative rate between the original treatment area and the original control area was significantly higher after treatment; however, the mean relative rate of the original treatment area compared with the expanded control town was not significantly different before and after treatment (Table 2).

Deer hunt

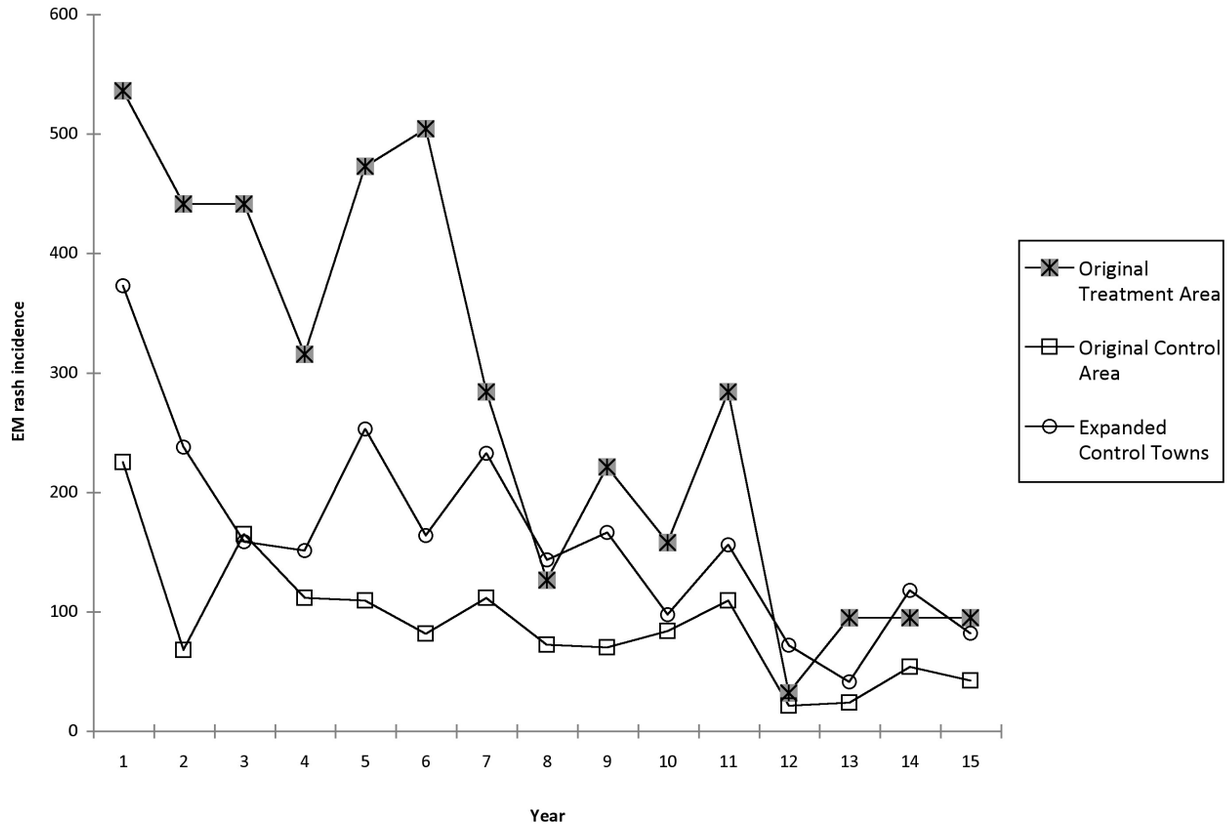
The deer hunt analysis did not show a clear decreasing trend in EM rash incidence in the original treatment area (Figure 3). The annual number of cases and the relative rates of EM rash incidence between the original treatment area and original control area, and the original treatment area and expanded control towns are shown in Table 3. In the original treatment area, the mean incidence rate before treatment was 450.8 cases per 100,000 population (SD=407.6); after treatment, the mean incidence rate was 245.9 cases per 100,000 population (SD=366.6). The mean incidence rate was not significantly different before and after treatment ($U=32.5$, $p=0.432$). Neither the mean relative rate between the original treatment area and original control area, nor the mean relative rate between the original treatment area and expanded control towns was significantly different before and after treatment (Table 2).

DISCUSSION

We evaluated the effectiveness of two deer-targeted interventions on reducing EM rash incidence in an LD endemic area. We found some evidence that the four-poster devices may have reduced the mean EM rash incidence in the original treatment area. The deer hunt was not shown to have had a statistically significant effect on mean EM rash incidence in the original treatment area.

The four-poster results are consistent with other studies that showed the device was effective at reducing

Figure 2. Annual incidence of Lyme disease cases per 100,000 population in the four-poster original treatment area, original control area, and expanded control towns:[a] Connecticut, 1992–2006[b]



[a]The original treatment area is a four-poster treatment area; the original control area is a similar area in Old Saybrook, Connecticut; expanded control towns include surrounding towns of Clinton, Deep River, East Haddam, East Lyme, Haddam, Killingworth, Old Lyme, and Old Saybrook.

[b]The after treatment period is 1999–2006.

EM = erythema migrans

tick populations[8–11] and with computer simulations suggesting that acaricidal treatment of deer would prevent the most cases of LD.[26] Meta-analyses for all the states indicated that the NEATCP effectively reduced the relative density of nymphs and provided 71% nymphal control by the sixth treatment year. The entomologic risk for LD was reduced 68% overall in treated vs. control areas among the five study sites by the study's end.[13,27,28]

A decrease in EM rash incidence was seen both before and after treatment and compared with the original control area. This finding could indicate that the decrease observed was not only the result of a general decrease in EM rash in the area. However, when the original treatment area was compared with the expanded control towns, the decrease in mean relative rates of EM rash was not significant. This inconsistency could indicate that the results may be due to random variation, a general decreasing trend in EM rash incidence, or from lower relative reductions in tick abundance in Old Lyme compared with other NEATCP sites.[13,14]

In Mumford Cove, reducing the number of deer did not have a significant effect on the reported EM rash incidence despite a significant decrease in tick abundance (Unpublished data, Kilpatrick HJ, LaBonte AM, Stafford KC 3rd. Effects of hunting on deer density, tick abundance, and human cases of Lyme disease in a residential community. 2010). There was a 45% decrease in mean EM rash incidence after treatment in the original treatment area and a 46% decrease after treatment in the relative rate of the original treatment area compared with the original control area. This rate was less than the community survey reported by Kilpatrick and LaBonte, which showed a decrease from 33 cases in 2000 to five cases in 2001.[18]

Table 1. Number of cases and relative rates of Lyme disease in the four-poster original treatment area vs. original control area,[a] and the original treatment area vs. expanded control towns: Connecticut, 1992–2006[b]

Year	Number of cases in original treatment area	Number of cases in original control area	Relative rate in original control area	Number of cases in expanded control towns	Relative rate in expanded control towns
1992	17	97	2.38	146	1.44
1993	14	29	6.56	93	1.86
1994	14	71	2.68	62	2.79
1995	10	48	2.83	59	2.09
1996	15	47	4.34	99	1.87
1997	16	35	6.21	64	3.09
1998	9	48	2.55	91	1.22
1999	4	31	1.75	56	0.88
2000	7	30	3.17	65	1.33
2001	5	36	1.89	38	1.63
2002	9	47	2.60	61	1.82
2003	1	9	1.51	28	0.44
2004	3	10	4.08	16	2.32
2005	3	23	1.77	46	0.81
2006	3	18	2.27	32	1.16

[a]The original treatment area is a four-poster treatment area; the original control area is a similar area in Old Saybrook, Connecticut; expanded control towns include surrounding towns of Clinton, Deep River, East Haddam, East Lyme, Haddam, Killingworth, Old Lyme, and Old Saybrook.

[b]The after treatment period is 1999–2006.

One explanation for the discrepancy was the source of EM rash reports: CT DPH vs. self-report. Underreporting of cases likely impacted our results.[29] It's also possible that self-reported LD cases were overreported in the community survey. Finally, cases were reported at the household level in the Kilpatrick study vs. the individual level in this study. However, none of our cases was reported from the same household, so this effect was likely limited. The small population size and low number of EM rash cases reported from Mumford

Table 2. Results from a comparison analysis of deer-targeted interventions between the original treatment and original control areas and expanded control towns, and before and after treatment: Connecticut, 1992–2006[a]

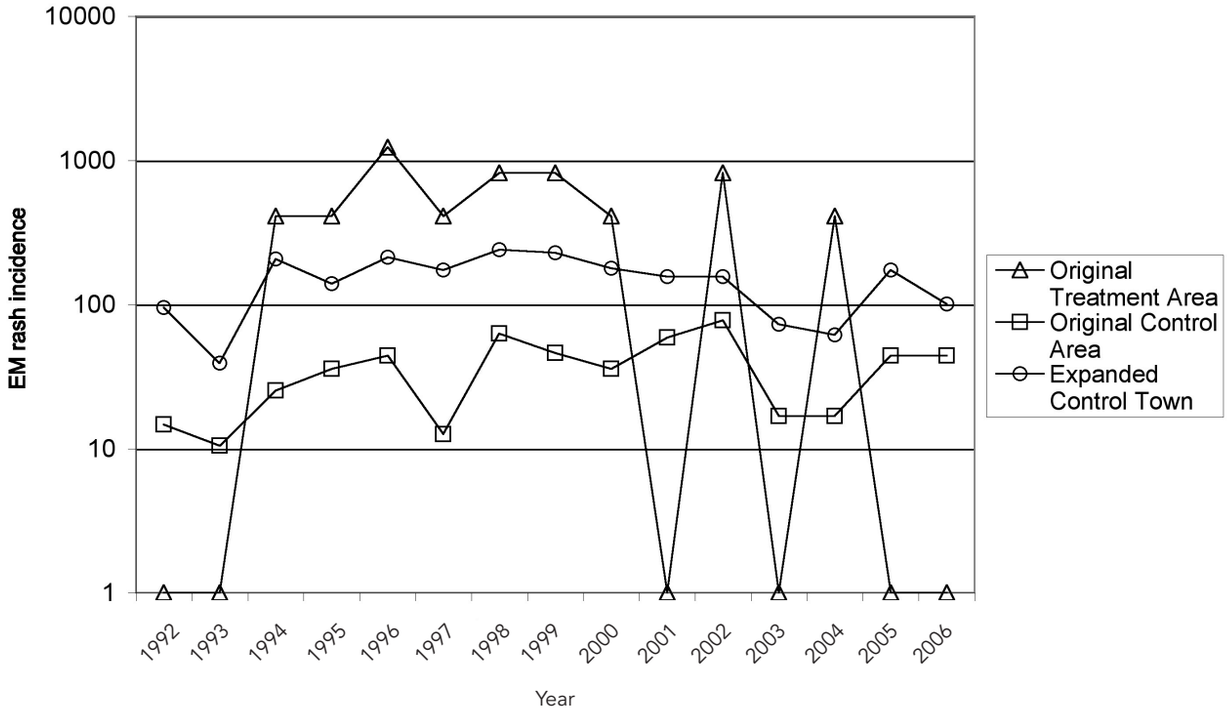
Intervention	Relative rate	Standard deviation	Test statistic	P-value
Four-poster[b]				
Original treatment area: original control area (before treatment)	3.93	1.80		
Original treatment area: original control area (after treatment)	2.38	0.87	U=74.0	0.040
Original treatment area: expanded control towns (before treatment)	1.91	0.75		
Original treatment area: expanded control towns (after treatment)	1.36	0.63	t=1.54	0.149
Deer hunt[c]				
Original treatment area: original control area (before treatment)	13.04	11.29		
Original treatment area: original control area (after treatment)	6.99	10.75	U=30.5	0.244
Original treatment area: expanded control towns (before treatment)	2.24	1.86		
Original treatment area: expanded control towns (after treatment)	2.38	3.30	U=38.5	0.864

[a]The after treatment period is 1999–2006.

[b]The original treatment area is a four-poster treatment area; the original control area is a similar area in Old Saybrook, Connecticut; expanded control towns include surrounding towns of Clinton, Deep River, East Haddam, East Lyme, Haddam, Killingworth, Old Lyme, and Old Saybrook.

[b]The original treatment area is Mumford Cove, the original control area is the rest of Groton, and the expanded control town is Stonington, Connecticut.

Figure 3. Annual incidence of Lyme disease cases per 100,000 population for the deer hunt original treatment area, original control area, and expanded control town:[a] Connecticut, 1992–2006[b]



[a]The original treatment area is Mumford Cove, the original control area is the rest of Groton, and the expanded control town is Stonington, Connecticut.

[b]In 1992, 2001, 2003, 2005, and 2006, no cases were reported from the treatment area. Symbols below the x-axis represent no cases per 100,000 population. The after treatment period is 2002–2006.

EM = erythema migrans

Cove limited this study's power and likely prevented this analysis from detecting a significant effect. This study highlights some of the difficulties in measuring the impact of tick management on disease incidence as opposed to tick abundance and the assumed LD risk.

While our results on reported LD incidence were not consistent with previous studies of deer reduction,[15,16] islands and other geographically isolated tracts allow for the elimination, or substantial reduction, in deer numbers greater than may be possible for mainland deer populations. In computer simulations, LD disappears when deer are eliminated. There may, however, be a transient increase in cases in the first two years due to availability of unattached ticks and an increase in the proportion of infected ticks.[17,26] Additionally, estimating mainland deer populations may be difficult within an urban forest landscape, which can reduce deer visibility, resulting in larger populations than expected.[30]

For both the four-poster and deer hunt analyses, the standard surveillance case definition increased the likelihood that the cases were consistent between treatment and control areas as well as over time. The interventions were also evaluated with respect to the ultimate outcome: LD as measured by EM rash, rather than an intermediate step in the exposure pathway: tick density. Finally, the control populations helped account for EM rash trends in the areas over time.

Limitations

The study design had several limitations. One limitation was that the LD surveillance system in Connecticut changed during the study period. Old Lyme, Old Saybrook, and the four-poster expanded control towns were under active surveillance for the entire study period. However, Groton and East Lyme were only under active surveillance from 2001 to 2006, likely influencing reporting rates in those areas. Stonington did not have active LD surveillance during the study

period. However, EM rash incidence in Stonington was similar to towns with active surveillance, so the effect may have been minimal. Changes in physician reporting patterns over time could have also affected the results if reporting patterns differed between treatment and control areas over time.

The four-poster population had an additional limitation. We assumed the populations in the census blocks that were intersected by the treatment boundary were evenly distributed across that census block in the original treatment area. If residences were congregated in one portion of the census block, then the actual population in the original treatment area may have been different depending on the residences' true distribution. However, 78.9% of the census blocks in the original treatment area were completely contained within the original treatment area, so this likely had a minimal impact.

Additionally, we excluded cases in the original treatment area and original control area that could not be accurately geocoded, assuming an equal proportion of cases were geocoded in the original treatment area and the original control area. If the addresses that were excluded due to geocoding issues were not evenly distributed throughout the study area, then the incidence estimates may be inaccurate. The expanded control towns' evaluation had an additional limitation because cases in the expanded control towns did not need to be geocoded to calculate incidence. The expanded control towns likely contained more cases than the original treatment area, as no cases were excluded from the expanded control towns on the basis of address. Therefore, the relative rates of the original treatment area to expanded control towns may not be an accurate representation of the true relative rates.

Finally, we did not survey individuals, so other confounding factors may have been present. Behavioral, environmental, and socioeconomic factors may have affected the results if there were differences between the original treatment area and original control area. In particular, because the Mumford Cove residents voted to decrease the deer population, they may have been more aware of LD and, thus, practiced more protective behaviors before the hunt. Additional studies may help reduce the effect of potential confounders and further evaluate the significance of our findings.

CONCLUSIONS

Our findings suggest that the four-poster device was effective in decreasing the incidence of EM rash in an endemic area. Despite a decrease in EM rash incidence, however, we did not find a statistically significant effect of the deer hunt on EM rash incidence, probably due to LD reporting issues, study design limitations, and the small population size. Further study is necessary to conclusively evaluate the effect of deer-targeted tick-control interventions on LD incidence. A prospective, multiyear study designed with consistent surveillance methods, a large population, and established control

Table 3. Number of cases and relative rates of Lyme disease in the deer hunt original treatment area vs. original control area,[a] and the original treatment area vs. expanded control town: Connecticut, 1992–2006[b]

Year	*Number of cases in original treatment area*	*Number of cases in original control area*	*Relative rate in original control area*	*Number of cases in expanded control town*	*Relative rate in expanded control town*
1992	0	7	0.00	17	0.00
1993	0	5	0.00	7	0.00
1994	1	12	16.26	37	1.98
1995	1	17	11.48	25	2.94
1996	3	21	27.88	38	5.79
1997	1	6	32.53	31	2.37
1998	2	30	13.01	43	3.41
1999	2	22	17.74	41	3.58
2000	1	17	11.48	32	2.29
2001	0	28	0.00	28	0.00
2002	2	37	10.55	28	5.24
2003	0	8	0.00	13	0.00
2004	1	8	24.40	11	6.67
2005	0	21	0.00	31	0.00
2006	0	21	0.00	18	0.00

[a]The original treatment area is Mumford Cove, the original control area is the rest of Groton, and the expanded control town is Stonington, Connecticut.

[b]The after treatment period is 2002–2006.

areas could provide reliable data for analyzing the effectiveness of deer-targeted interventions. A combination of deer-targeted and other interventions, such as education, may ultimately prove to be successful in preventing LD in endemic areas.

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