# Public Education and Lyme Disease Prevention in Monroe County: A Multi-Faceted Program of Personal Protection Strategies, Tick Identification/Risk Assessment, Bi-Directional Referrals, and Vector Control

Jacquelyn A. Hakim[1] and Adenike Bitto[2]

[1]*Monroe County Vector Contro*
[2]*East Stroudsburg University*

## Abstract

The purpose of this paper is to share findings and results from a six-year Lyme disease (LD) prevention program in Monroe County, PA. LD is hyper-endemic among ticks in Monroe County and much of the Northeast. In May 1996, an initial survey of the Delaware Water Gap National Recreation Area (DWGNRA) established baseline data for tick densities and species, lifecycle occurrence, and infection rates. LD infection rates were extremely high, up to 63% of Ixodes species tested. Monroe County Vector Control (MCVC) has instituted an innovative prevention program. Community members bitten by ticks who seek medical care are referred to MCVC by their physicians. In some instances, community members bring samples directly to MCVC for tick identification and risk assessment, conducted using regression equations for duration of attachment (Falco et al., 1996; des Vignes et al, 2001). Each individual receives counseling, health education and, if necessary, prompt medical referral to prevent complications of LD. MCVC also conducts LD and tick seminars as requested by the community. Data is presented on the occurrence of ticks by life stage and gender, duration of tick attachment to humans, and health education techniques utilized. The low number of LD cases reported, relative to the number of LD positive ticks and tick bites, indicates that MCVC Lyme disease prevention strategies are successful. This model can be replicated in other regions.


*Keywords: Lyme disease, community health, prevention, risk*

## Introduction

Lyme disease is the primary vector-borne disease in the United States today, infecting over 17,000 people in 2000. The hyper-endemic areas include the north-central states and much of the northeast and mid-Atlantic areas, with 14,932 cases in the East (Center for Disease Control [CDC], 2000). It is a spirochete infection transmitted from rodents to humans by means of the bite of an infected tick of the genus Ixodes. Lyme disease (LD) appears to have arrived in northeastern Pennsylvania in ticks carried up the Delaware River Valley by migrating deer populations, and the first identified locus of LD cases occurred in Park Rangers in the Delaware Water Gap National Recreation Area (DWGNRA.).

While many researchers conclude that Lyme disease causes considerable health-related quality of life issues, the literature about this disease has been consistently contradictory and biased. Expert commentary often labels the disease "Protean," likening it to the Greek god Proteus, who eluded his enemies by changing his physical form. Others disagree, stating that this is a great overstatement and the disease is much more readily understood and subdued (Nadelman & Wormser, 1998). Some researchers maintain that LD is over diagnosed (Steere, Taylor, McHugh, & Logigian, eds, 1993), while others consider the disease underreported, misdiagnosed, and poorly identified and treated (Brenner, Gabriel, & O'Donnell, 1993).

Since the early 1990s, there has been considerably more research and documentation on the latency period, the co-infections, treatment strategies, and the tests necessary to diagnose or rule out LD in a patient presenting with tick bite, with other symptoms, but without the classic erythema migrans (CDC 1996; Hilton, DeVolti, Benach, Halluska, & White, et al. 1999; Fish, 1998, Goodman, 2001; Sigal, 2003).

Clinical trials in hyper-endemic Westchester County, NY regarding the prophylactic treatment of LD found that one 200 mg dose of doxycycline within 72 hours of a tick bite will effectively prevent the development LD infection (Nadelman, Nowakowski, Fish, Falco, & Freeman, et al. 2001). Nevertheless, prophylaxis is predicated on an accurate identification of the arthropod and a correct assessment of the length of time of attachment (Shapiro, 2001; Falco, Fish, & D'Amico, 1998; Nadelman, 2001). Physicians are almost as likely to misidentify specimens as lay people, making the role of the medical entomologist a necessity in the decision to treat or not treat prophylactically (Falco, Fish, & D'Amico. 1998; Shapiro 2001).

Most primary care physicians have a difficult time diagnosing Lyme disease in a person who does not recognize or remember a tick bite exposure. Symptoms can be arbitrary or absent in the early stage. The critical symptom, erythema migrans, is too often absent or unnoticed. Tests can be inconclusive or false negative, especially in the early weeks after exposure. Although no doctor wants to use antibiotics capriciously, there is always the risk that the patient could be incubating this treacherous pathogen and will later have serious medical problems that are much more difficult to treat.

Patients often go for medical treatment immediately after a tick bite, without knowing if the tick was capable of disease transmission. At MCVC, we understood that we could assist the local physicians by triaging out all the tick bite cases that posed NO threat of LD.

**Materials and Methods**

In 1996, after obtaining the necessary Federal permits for collecting in a National Park, we began a study of tick species, densities and infection rates in the DWGNRA to establish a temporal-life stage database for risk of contracting LD in that specific area. We established a site of 1170 feet of a forest trail in the Recreation Area known as Turn's Farm. The study site was dragged (using a $2m^2$ white flannel horizontal drag) and flagged (using a $0.5m^2$ white flannel vertical flag) twice weekly for the first year of the study. The collected ticks were labeled and brought back to the laboratory for identification and Figure 1serology, which included dark-field microscopy and culture in BSK. The study continued for two additional years, adding and verifying our initial data, with the exception of a small nymphal collection in 1998, probably due to weather conditions. Based on the characterization of the ticks and the LD incidence rates, we have been able to devise an educational strategy for the public and the health care providers; a multi-faceted program of personal protection tactics, tick identifications, risk assessments, bi-directional referrals, and vector control.

**Results: Temporal-Life Stage Collections**

Our initial survey in 1996 supplied us with 259 Ixodes samples (see Table 1 and Figure 1), of which 32% were males, 27% were females, 21% were nymphs and 18% were larvae.

Males had the highest infectivity rates, at 63%. Temporal-life stage data from 1996 and 1997 show similar patterns for the monthly samples (see Table 1, Figure 1; and Table 2, Figure 2).

Table 1
Incidence of *Ix. scapularis* in the DWGNRA 1996 in Monroe County

| | Month | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| Life stage | | | | | | | | | |
| Larval | 0 | 7 | 2 | 0 | 34 | 1 | 4 | 0 | 0 |
| Nymphal | 0 | 13 | 25 | 15 | 3 | 0 | 0 | 0 | 0 |
| Male | 29 | 4 | 0 | 0 | 0 | 0 | 30 | 13 | 8 |
| Female | 25 | 3 | 1 | 0 | 0 | 0 | 30 | 7 | 5 |
| | | | | | | | | | |
| Totals | 54 | 27 | 28 | 15 | 37 | 1 | 64 | 20 | 13 |
| | | | | | | | | | |
| | | | | | | | | Totals | 259 |

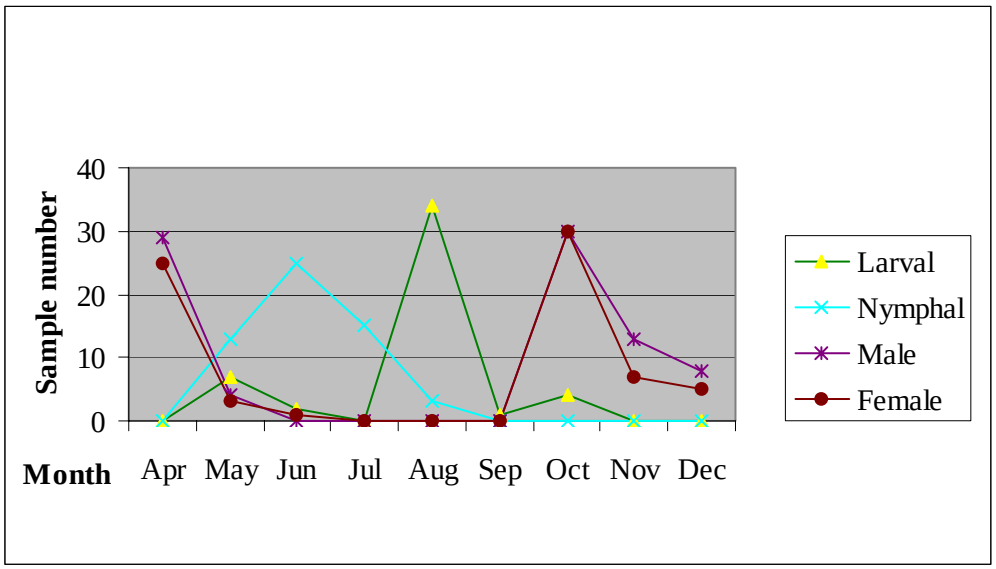


Figure 1
Incidence of Ix. scapularis in the DWGNRA, Monroe County 1996

Collections support the fact that larval populations peak in summer, nymphal populations peak in May and June, and adults are active throughout the fall and winter months, and do not totally disappear until late spring. Table 1 and Figure 3 show an earlier portion of the year, when the adults were questing for a blood meal, and the larvae and nymphs were absent in the collections. The nymphal stage, May through August, is the most likely time of year for exposure to LD, due in part to the small and easy-to-miss size of the ticks, and also to the increase in human outdoor activities in potential tick habitats.

Table 2
Incidence of *Ix. scapularis* in the DWGNRA – Monroe County 1997

| | **Month** | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Apr** | **May** | **Jun** | **Jul** | **Aug** | **Sep** | **Oct** |
| Life stage | | | | | | | |
| Larval | 0 | 0 | 0 | 0 | 14 | 0 | 0 |
| Nymphal | 0 | 2 | 12 | 21 | 5 | 0 | 0 |
| Male | 17 | 5 | 0 | 0 | 0 | 0 | 11 |
| Female | 6 | 6 | 1 | 0 | 0 | 0 | 12 |
| | | | | | | | |
| Totals | 17 | 13 | 13 | 21 | 19 | 0 | 23 |
| | | | | | | Totals | 106 |

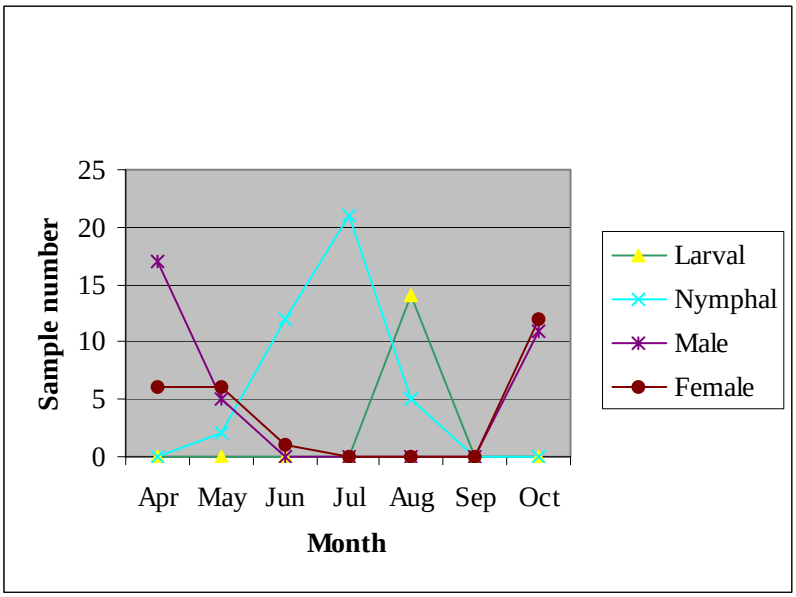


Figure 2
Incidence of *Ix. scapularis* in the DWGNRA – Monroe County 1997

Table 3
Incidence of *Ix. scapularis* in the DWGNRA – Monroe County 1998

| | **Month** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** | **Jul** | **Aug** |
| Life stage | | | | | | | | |
| Larval | 0 | 0 | 0 | 0 | 0 | 0 | 62 | 81 |
| Nymphal | 0 | 0 | 0 | 0 | 2 | 4 | 2 | 2 |
| Male | 0 | 8 | 19 | 21 | 1 | 3 | 0 | 0 |
| Female | 0 | 12 | 22 | 15 | 2 | 0 | 0 | 0 |
| Totals | 0 | 20 | 41 | 36 | 5 | 7 | 64 | 83 |
| | | | | | | | Totals | 256 |

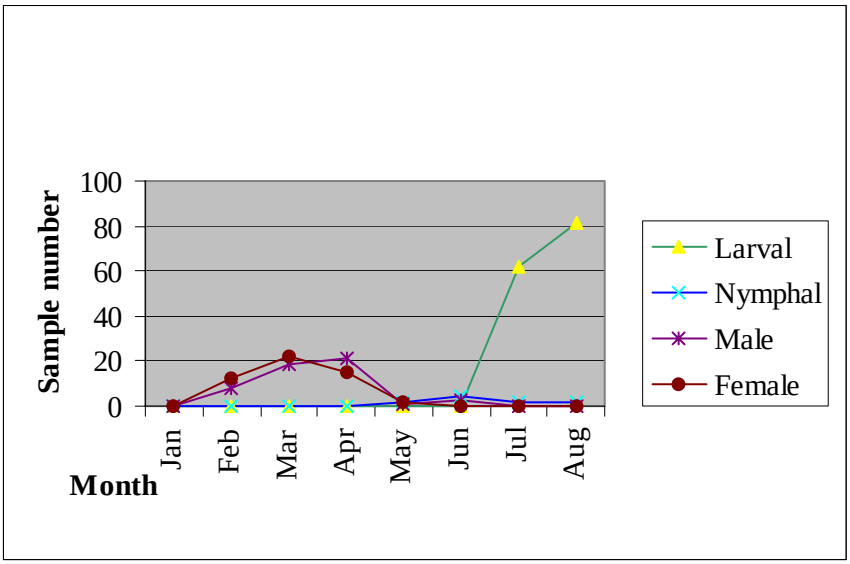


Figure 3
Incidence of *Ix. scapularis* in the DWGNRA – Monroe County 1997

An average of thirty four percent of the Ixodes ticks collected from the Turn's Farm site tested positive for Borrellia burgdorferii, the causative agent for LD, as indicated by dark-field microscopy and confirmed by bacterial culture. Ticks from the eastern border of Monroe County -- the Delaware River -- have the highest infection rates, and those from the western border -- the Lehigh River -- have the lowest, as confirmed in testing done in the laboratories of Dr. Richard Dryden, Washington-Jefferson College, and Dr. Jane Huffman, East Stroudsburg University.

**Results: Assessment of risk**

Our risk assessment consists first of identification of tick with respect to species and life stage, as larval and male ticks do not transmit LD. The second step is the determination of scutal index, the measurement of two body parts, which gives us a ratio of a body part that does not change with engorgement vs. the length of the body, which increases with engorgement (see Figure 4). The last step is to plug the scutal index into a regression analysis, giving us the number of hours of attachment (Falco, Fish, & Piesman, 1996) (see Figure 5). We know that Lyme disease is a function of all of these parameters, as well as of endemicity of the causative organism, which we have already established for Monroe County. The duration of attachment is also critical to the risk of LD infection. A time-span of forty-eight hours is essential to the spirochetes' ability to respond to mammalian blood, their migration to the salivary glands of the tick, changing their outer surface protein coat, and traveling down the hypostome into the new host (Piesman, Mather, & Sinsky et al. 1987). Repeated experimental data shows this to be true of Lyme disease; however, it is not necessarily true for other tick-borne pathogens.

Based on our findings, our local physicians are likely to treat a patient who has been bitten by a nymphal or female Ixodes tick, with an established bite duration approaching or exceeding 48 hours.

As more physicians refer to us, and residents tell their friends and neighbors, the number of tick identifications we perform has gone up dramatically. In 1998, the number was a few dozen. In 2001, it was 250. In 2002, we have done over 350. Ticks have been mailed to us from upstate NY, northwest NJ, the Lehigh Valley, and all over Eastern Pennsylvania.

Scutal Index = A/B

- Body length, from base of mouth parts to end of abdomen, **"A"**
- Width of scutum at widest point, **"B"**
- **"A"** elongates with feeding time
- **"B"** stays constant

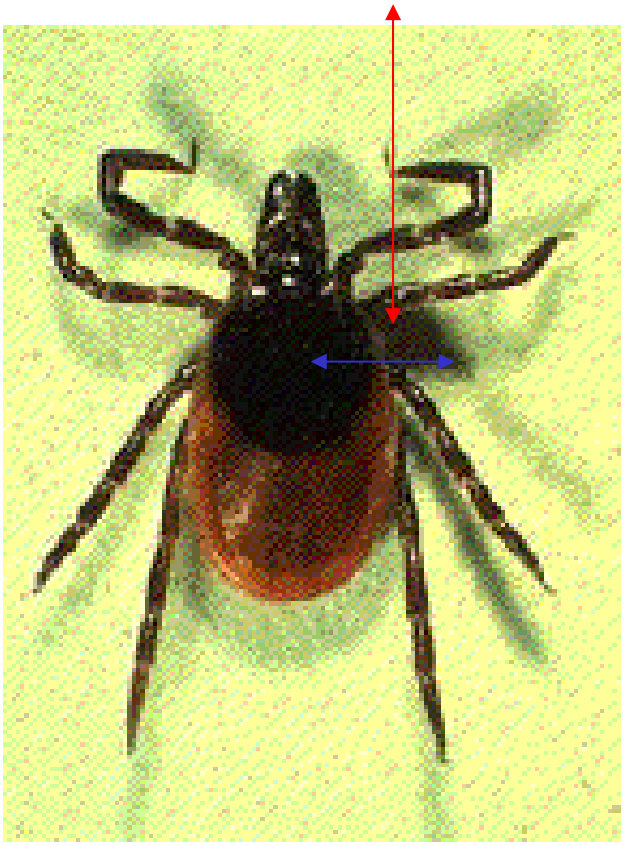

Figure 3
(Falco, Fish, and Piesman, 1996)

Since our study ended in 1998, MCVC has been the community's resource for the identification of ticks, and for the risk-assessment of contracting LD for anyone bitten by tick in Monroe County. Many physicians direct the tick samples to us before seeing the patient, saving valuable time and resources for both.

**Results: Implementation of Educational Strategies**

Our study concluded that LD is endemic in Monroe County. Now, when people bring in ticks, staff spends time with each one, explaining what is being done in the risk assessment, informing them of tick ecology, proper removal techniques, and personal protection strategies. We also answer their questions and send them home with a brochure

that reiterates the information for future reference.

If the tick is a non-Ixodid, we counsel them on protective measures and send them home with the informational brochure. If the tick has met the criteria for transmission, we inform them that they need to call their doctor, who will usually treat prophylactically with a course of antibiotics. Our risk assessments are only valid for residents of Monroe County, as we have no data on other counties' tick infection rates. For others, we can give identification to species, life stage and engorgement level, as well as information for avoiding ticks in the future.

As personal protection and awareness are the key components in avoiding Lyme disease, we recognize the importance of public education in keeping our community safe. Area residents have collaborated with us to produce and post tick awareness flyers in hyper-endemic areas to warn hikers and campers, and to give the location and telephone number of our office for tick identifications and risk assessments.

Because Lyme disease is the most likely disease to be picked up from an arthropod in Northeastern Pennsylvania, many people are extremely interested in the subject, and it is the topic we are most often asked to address when we are invited to speak. Our audiences have been political clubs, community service organizations, summer camps, bank employees, 4-H clubs, Penn State Cooperative Extension programs, PA Department of Agriculture pesticide license update certification seminars, and our local hospital's microbiology lab staff.

**Discussion**

It has been estimated that LD costs society over a billion dollars per year in medical expenses, missed work, sick time, and general morbidity. The medical risk of using a short course of doxycycline (or amoxicillin for children) is extremely low in contrast to the risk of contracting and treating later-stage Lyme disease. We do not advocate the treatment of every tick bite. That would be absurd and medically malfeasant. Our assessment allows the physician to consider only the individuals who meet the criteria of suspected Lyme exposure: the right tick, in the right life stage, the 48+ hours of exposure, and the known local infection rates. It also protects the not-at-risk individuals from the costs and risks of unnecessary treatment.

Tick identification and risk analysis can be done at any health department, hospital lab, extension service office or local college. Our colleagues have already done the research. All that one needs to do this work is a medium-powered microscope with micrometer reticle, some basic training on tick anatomy, a taxonomic key for the ticks of one's geographic area, the regression equation, and epidemiological data on the local tick infection rates. In endemic or hyper-endemic areas for Lyme disease, this assessment program is well worth considering and implementing.

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**Acknowledgements**

The authors thank Jeffrey Slabinski and Leonard Forte for their assistance with the data collection, identifications, microscopy, and laboratory cultures; Michael Pula for his help in data presentation; and to all three for their dedication to Monroe County Vector Control's mission to Public Health.

The authors also thank Patrick Lynch and Jeffrey Schreiner of the National Park Service for cooperation in obtaining Federal permits for our collections.

Also, special thanks to Dr. Richard Dryden, Dr. Jane Huffman, and Joshua Courtney, for their tick identification confirmations and laboratory testing of our samples, and to their institutions, Washington-Jefferson College and East Stroudsburg University, for cooperating in our research.
No special funding was required for this research.

Author Information
Jacquelyn A. Hakim, MS, MPH, Director
Monroe County Vector Control
38 North 7th Street
Stroudsburg, PA 18360
Ph: 570-420-3525
E-Mail: jhakim@co.monroe.pa.us

Adenike Bitto, MD, MPH, DPH, CHES
Associate Professor of Health
East Stroudsburg University
200 Prospect Street
East Stroudsburg, PA 18301
Ph: 570-422-3375
E-Mail: abitto@po-box.esu.edu