

Lyme Disease Prevalence Among Construction Workers On Long Island, New York

**David K. Parkinson, MD
Angela De Vito, MSCM
Raymond J. Dattwyler, MD
Benjamin Luft, MD**

State University of New York at Stony Brook

John M. Kennedy

Building and Construction Trades Council, Nassau and Suffolk Counties

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Lyme Disease, *Borrelia burgdorferi* infection, is the most common vector-borne disease in North America and Europe. This infectious disease is widespread in areas where deer ticks are endemic. In the United States, the disease was reported in 43 of the 50 states in 1995 (CDC 1995). However, the vast majority of cases come from the northeast, mid-Atlantic, and north central regions: Connecticut, Maryland, Massachusetts, Minnesota, New Jersey, New York, Pennsylvania, Rhode Island, and Wisconsin (CDC 1996).

Lyme disease is progressive. Infection with *B. burgdorferi* produces a wide array of clinical abnormalities, major target organ systems being the skin, musculoskeletal system, and nervous system. The clinical presentation is variable; not everyone has the same signs and symptoms of infection. Some individuals may not show signs of disease until months or years after initial infection. Infection originates at the site of a tick bite with the spirochete disseminating through the blood supply early on, seeding all major organ systems, such as the heart, brain, muscles, and joints. Later, the disease can enter a latent phase or go on to a chronic phase where there are few, if any, systematic signs and symptoms.

Ticks are most commonly found in brush, wooded areas, and tall grass. Individuals working or playing in these areas are at high risk for tick bites and infection. New York State has the largest number of reported Lyme disease cases in the United States, with Suffolk and Westchester Counties having the highest rate of disease in the state. Studies show that outdoor workers in endemic areas have far greater incidence of infection than the general population (Smith and others 1988; Madal, Wunderli, Briner and Hansen 1989; Doby, Couatarmanac'h, Fages, and Chevrier 1989; Fahrner and others 1991). Studies of National Park Service employees working on Long Island's National Seashore recreational area demonstrated that 15 percent or more acquired the disease each year in the 1980s (Lyme Disease Center 1989-95). Studies from the Netherlands also have found that outdoor workers in endemic areas incur a significant increased risk of exposure (Kuiper and others 1991, 1993). Investigations of the membership of two Long Island construction trade unions, local unions 25 and 1049 of the International Brotherhood of Electrical Workers (IBEW), have identified positive Lyme disease test results at rates significantly above that for the general population in both counties (Long Island Occupational and Environmental Health Center 1990-94).

To build on the earlier study of IBEW members, the Building and Construction Trades Council (BCTC) of Nassau and Suffolk Counties, in collaboration with staff of the Long Island Occupational and Environmental Health Center and the Lyme Disease Center — both at the State University of New York at Stony Brook — conducted a pilot study of the prevalence of positive Lyme Disease test results among building trades workers.

Study Methods

Participant Selection

The Building and Construction Trades Council, with input from its member affiliates, generated lists of approximately 10,000 potential study participants, including carpenters, electricians, operating engineers, iron workers, laborers, sheet metal workers, plumbers, and painters. Each person on the list could be classified as working outdoors or indoors for the 6 months before the start of the sample

collection period, which began in July 1994. “Outdoor” workers reported working solely outdoors during the 6 months; “indoor” workers reported working solely indoors or predominantly indoors during that time. After the BCTC staff assembled the lists, the researchers chose a random sample of workers. (The sample included men and women but was not balanced to reflect the proportion of women in the worker population.)

Each worker so selected was contacted by telephone, had the study explained to him or her, and was offered an opportunity to participate in the free Lyme disease screening program. Of the sample of 556 workers, 408 attended. After the exclusion of retirees and workers whose records were missing, tests were conducted on 396 workers.

Screenings took place at local union halls at scheduled times and dates. At the screenings, first-year medical students explained the study to each worker and had the worker sign a human-subject consent form. Each worker completed a brief medical and occupational history and provided a history of known tick bites, as well as other information pertaining to risk for tick exposure. A blood sample of 5 milliliters was taken to allow for both analysis and serum storage.

Technical Description of Lyme Disease Tests

Enzyme-linked immunosorbent assay (ELISA). An ELISA for antibodies to *Borrelia burgdorferi* was performed with minor modifications. In brief, 96-well microliter plates (from Immulon 4, Dynatech, Chantilly, Virginia) were coated with a sonicate of *B. burgdorferi* (5 micrograms per milliliter [$\mu\text{g}/\text{ml}$]) for 18 hours in a 0.05 molar sodium carbonate coating buffer (pH 9.6) and then washed three times with Tris-buffered saline (pH 7.5) containing 0.05% Tween 20 (TBS/Tween). Excess binding sites on the wells were blocked by postcoating the wells with 200 μl (microliters) of Tris-buffered saline containing 5 percent non-fat milk (pH 7.5). The plates were washed as described above. Serums from all three study groups were diluted to 1:100 in TBS/Tween. Aliquots of 100 μl each were added to duplicate wells and incubated for two hours at 37° C or overnight at 4° C. The plates were washed, and alkaline-phosphatase conjugated goat anti-human immunoglobulin specific for light-chain and heavy-chain determinants was added to detect bound immunoglobulin of all isotypes. After incubation for two hours at 37° C, the wells were again washed three times in TBS/Tween. Then p-nitrophenyl phosphate (Sigma, St. Louis) at a concentration of 2 milligrams per milliliter in 0.15 molar sodium bicarbonate containing 1 millimole magnesium chloride was added to each well. Plates were incubated two hours at room temperature. The optical density of each well at 410nm was measured on an ELISA reader (Dynatech 5000, Dynatech) at 10 minutes, 15 minutes, 20 minutes, or until negative controls reached a range of 0.075 - 0.100.

Electrophoresis and immunoblotting (Western blot). *B. burgdorferi* organisms of the B31 strain were grown in BSK 1 media and washed three times in phosphate-buffered saline. Phosphate-buffered saline (PBS) is added to pelleted spirochetes in a volume equal to the volume of the pellet. *Borrelia* are usually dispensed in 100 μl aliquots. Protein concentration is measured according to a modified Bradford procedure. Average concentrations range from 18mg/ml to 22mg/ml. The 100 μl of *Borrelia* are mixed with 150 μl of sample buffer which is 10% SDS, 0.5M

TRIS, pH6.8. Then 10% B-2-mercaptoethanol is added and the mixture heated for 5 minutes at 95° C. SDS-PAGE gel electrophoresis is performed using a 12% gel in a Bio-Rad Protean 11 cell (Bio-Rad, Melville, NY). Western blotting is performed using Immobilon PVDF (polyvinylidene difluoride) membrane (Millipore, Bedford, Massachusetts) at 30 volts overnight, followed by 1 hour at 75 volts. Excess binding sites are blocked with phosphate-buffered saline containing 5% milk and 0.05% Tween-20 (PBS/Tween/Milk), pH7.5 for two hours. The PVDF membrane containing transferred proteins is then placed into an Immunetics MN25 miniblottedter apparatus (Immunetics, Cambridge, Mass.). Serum samples are diluted 1:150 in PBS/Tween/Milk and applied to the Immunetics device overnight at room temperature on a Hoefer red rocker (Hoefer Scientific Instruments, San Francisco). Bound immunoglobulin can be detected with a 1:1000 dilution of goat anti-human IgG (immunoglobulin gamma G), IgM (immunoglobulin gamma M), or IgA (immunoglobulin gamma A) conjugated to alkaline phosphatase (Sigma) in PBS/Tween/Milk incubated for two hours at room temperature. The blot is then washed once in PBS/Tween/Milk, once in PBS/Tween, and once in O.1M Tris Buffer pH 7.2, followed by incubation in the BCIP-NBT substrate system (5-bromo-4-chloro-3-indole phosphate-nitroblue tetrazolium (Kirkegaard and Perry Laboratories, Gaithersburg, Maryland) until color development is complete. The reaction is stopped by rinsing the blots in dH2O.

Results

Of the 396 participants tested, 43 (11%) were identified as Lyme-disease positive (on both the ELISA and Western blot tests). Those testing positive were sent a letter offering an evaluation at the Long Island Occupational and Environmental Health Center. Thirty-nine individuals were evaluated and the other 4 chose to see their own physicians. Of the 39 individuals evaluated, 3 were found to have evidence of chronic Lyme disease and are being followed by the Lyme Disease Center staff after a 6-week course of intravenous antibiotics. The remaining 36 were given oral antibiotics for 21 days.

Of the 43 workers with positive test results, a tick bite was reported by only 12 on the health survey. The remaining 31 either reported no evidence of tick bite and feeding or that they were unable to recall a bite.

Potential Factors

Indoor and outdoor work. Of the 143 individuals classified as indoor workers, 10 (7%) tested positive. Of the 253 individuals classified as outdoor workers, 33 (13%) were Lyme positive. This difference in rates of Lyme positivity is highly significant with a value $p < .001$. Several possibilities exist for this difference and analyses are in progress to elucidate the differences.

Worker age. The average age of indoor workers who tested positive was 46.8 years compared with 42.7 for the outdoor workers who tested positive (table 1). This difference was not significant. The average age of those testing negative was 44.2 and 40.2 years, respectively, for indoor and outdoor workers. Again, the difference between the two groups was not significant.

Table 1. Average ages of indoor and outdoor workers who tested positive and negative for Lyme disease (years)

<i>Test result</i>	<i>Outdoor</i>	<i>Indoor</i>
<i>Positive</i>	42.7	46.8
<i>Negative</i>	40.2	44.2

Length of time worked outdoors or indoors. Among the two groups of workers who tested positive for Lyme disease, the researchers found no significant differences in reported time worked outdoors or indoors (table 2).

Table 2. Time worked outdoors or indoors for workers testing positive and negative for Lyme disease (months)

<i>Test Result</i>	<i>Outdoors</i>	<i>Indoors</i>
<i>Positive</i>	55.1	50.4
<i>Negative</i>	35.2	46.1

The difference in months worked outdoors between workers testing positive and negative was significant at $p < 0.05$.

Outdoor hobbies. Many workers have outdoor hobbies such as bird watching, camping, fishing, golfing, and hunting in the Long Island region, a factor that increases risk of exposure to deer ticks and possible Lyme infection (table 3). All 10 of the indoor workers who tested positive reported outdoor hobbies.

Table 3. Positive Lyme disease test results compared with reported outdoor recreation

<i>Outdoor recreation?</i>	<i>Positive test results</i>	
	<i>Outdoor workers (number)</i>	<i>Indoor workers (number)</i>
<i>Yes</i>	23	10
<i>No</i>	10	0

The data support the widely held belief that outdoor recreation is a source of exposure to the deer tick and Lyme disease infection.

Discussion

The tests show a significantly higher rate — 13% — of positive Lyme disease tests for construction workers *employed outdoors* on Long Island. In comparison, construction workers employed indoors had a prevalence rate of 7%, which approximates the rate found in the general population on Long Island, 6%. The finding suggests increased risk of infection associated with outdoor work.

The Role of Time Employed Outdoors

The length of outdoor work for those with positive test results was significantly greater than that for the outdoor workers who tested negative, suggesting outdoor work as a risk factor.

The Role of Outdoor Recreation

It is likely that outdoor recreation has a limited role in exposure potential for Lyme disease. Although many construction workers reported outdoor hobbies, 10 of the 33 outdoor workers testing positive did not report such activities. Outdoor hobbies can, in most cases, contribute only about 30% of the exposure potential for outdoor workers (2 days of recreation as compared with 5 days at work); the exception would be for workers who camp outdoors overnight, extending the ratio of potential exposure during outdoor recreation to 50% or more.

Even among the indoor workers with positive test results, it is difficult to imagine that their reported outdoor hobbies are solely responsible for the exposure. Some of those grouped with indoor workers may have previously worked outdoors or may have a second, outdoor job that was not reported to the investigators. Further, the reported outdoor recreation may have occurred off Long Island in non-deer-tick areas.

Recommendations

A total of 43 positive test results were found — 11 % of the total sample — although only 12 of the 43 reported tick bites. Unless an aggressive search for ticks is made, many opportunities to prevent infection are missed. We have no estimates of how many of the 43 individuals will develop chronic Lyme disease but 3 already have and needed prolonged intravenous antibiotic treatment at a cost of about \$15,000 each. This pilot study demonstrates that infection with Lyme disease is a significant health problem affecting outdoor workers on Long Island and that a training program for prevention of Lyme disease should be established, coupled with regular testing. We propose expanding this preliminary study to attempt to further identify risk factors in the outdoor population and to develop a training and education program.

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