Lyme Disease: A Prospective Study of Outdoor Workers

by

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This is to verify that **Colleen Parrott**

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ABSTRACT

Lyme disease is the most frequently diagnosed tick-borne illness in the United States. Maryland alone reported 138 confirmed cases of Lyme disease during 1989.

Assateague Island in Berlin, Maryland is considered an endemic area for Lyme disease. This project was a prospective epidemiological study, which was developed to assess the occupational risk of Lyme disease in Assateague Island State and National Seashore Park workers.

The study focused on seroconversion, tick bite exposure and preventive practices used to avoid tick bite exposure. Ninety-nine subjects were enrolled during Phase I of the study, which consisted of the administration of a questionnaire and a venous blood sample for Borrelia burgdorferi antibody detection. During Phase II of the study, eighty-six subjects were enrolled. Again, a second questionnaire was administered and a repeat venous blood sample collected.

Using a chi-square analysis and t-test, the researcher identified that a significant relationship existed between time spent in the marsh and the number of tick bites experienced. A trend was observed when examining the relationship between time spent in the woodland and the number of tick bites experienced. There was no significant relationship between preventive measures practiced and the number of tick bites experienced, nor was seroconversion identified.

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CHAPTER I

Introduction

Lyme disease is a growing public health concern. It is well documented that Lyme disease is a tick-borne illness caused by the spirochete Borrelia burgdoferi (Steere, Grodzicki, Kornblatt, Craft, Barbour, Burgdofer, Schmidt, Johnson, and Malawista, 1983). Ixodes dammini also known as the deer tick, is the most important vector of Lyme disease in the Northeast United States (Steere, 1989). It is a small tick which has a two year life cycle, consuming one blood meal during each of its three stages of development. Common hosts for the Ixodes dammini tick include the white-footed mouse and the white-tailed deer. Additionally, this vector can be found on humans, raccoons, cattle, horses, and birds.

Lyme disease is a complex disease which may affect the heart, skin, joints and nervous system (Habicht, Beck and Benach 1987). As with other spircochetal infections, Lyme disease occurs in stages with different clinical manifestations. The first stage generally occurs 3 to 30 days after the bite of a tick, with 50%-70% of the persons developing a common rash known as erythema chronicum (Schwartz and Goldstein, 1989). The second stage occurs weeks to months after the tick bite, whereby a person exhibits cardiac and neurological symptoms. Finally, the third stage occurs months to years after the tick bite and

causes joint involvement which may become crippling (Schwartz et al. 1989). The clinical stages may overlap, occur alone or remain absent (Steere, 1983). However, treatment is imperative to arrest the clinical disease process.

Lyme disease is the most frequently diagnosed tick-borne illness in the United States (Habicht, et al.1987). From the years 1982 to 1986, the number of cases increased from 491 to 1394 (Ciesielski, Markowitz, Horsley, Hightow Russell, and Broome, 1988). During this time, a standardized case definition was utilized by the CDC, yet many states did not mandate reporting of this illness. However, through continued national surveillance efforts, increased reporting requirements, and improved identification of the disease, health officials continue to find an astonishing rise in number of Lyme disease cases. From 1987 to 1988, cases of Lyme disease nearly doubled from 2369 to 4507, producing an average annual incidence of 1.4/100,000 in the nation for this time frame (Tsai, Bailey, Moore, and Phil, 1989).

The region reporting the highest incidence of Lyme disease in 1988 was the Mid-Atlantic region, encompassing New York, New Jersey, and Pennsylvania. Maryland alone reported 138 confirmed cases of Lyme disease during 1989 (Maryland Department of Health and Mental Hygiene, 1990).

Due to the rise in cases of Lyme disease, factors which place an individual at risk become extremely

important. Paramount is the lack of education regarding Lyme disease, its transmission and prevention. Secondly is human activity in a tick-infested area, particularly in the spring and summer months.

In reviewing the literature, occupational studies assessing the risk of acquiring Lyme disease are quite limited. However, in the studies reviewed an association between outdoor workers and seropositivity for Lyme disease antibodies has been demonstrated. Acknowledging the increased risk to outdoor workers, it becomes evident that a considerable high risk population exists, since it is estimated that there are 3.6 million workers in the United States employed in agriculture, hunting, forestry and fishing (Schwartz, et al.,1989).

To date, strategies to control the spread of Lyme disease have centered around preventive measures practiced by individuals, such as the use of insect repellant, wearing of light colored clothing, inspection for ticks, proper tick removal, and awareness of Lyme disease signs and symptoms. Environmental control measures include the burning and cleaning of brush, environmental chemical application, and the application of acaricide on animal hosts.

Strategically, community health nurses are in a position to play a key role in the prevention of Lyme disease. Community health nurses are concerned with three levels of prevention. Primary prevention is concerned with

health promotion and protection against disease. Often, the form this takes in community health nursing is intervention at the population level. Secondary prevention focuses on early diagnosis and intervention in the disease process. Tertiary prevention involves rehabilitation activities to prevent further problems or complications and restore optimal functioning (Archer, 1979). Recognizing the three levels of prevention and the roles community health nurses assume as educators, program planners, researchers, and practitioners, it is apparent that the delivery of nursing care at each level will have a positive effect in interrupting the Lyme disease process.

This research project proposes to assess the occupational risk of Lyme disease for workers within the Assateague Island State and National Seashore Parks in Maryland, by identifying seroconversion in this defined population.

Assateague island is a barrier island located off the eastern shore of Maryland and Virginia. The island is 37 miles long and is comprised of sandy beaches, dune vegetation, pine woodland, shrub thicket and salt marsh. Wildlife on Assateague Island includes but is not limited to migratory birds, sica deer, raccoons, wild ponies, red foxes, white-tailed deer and white-footed mice, all of which have been identified as hosts for the tick vector.

Results of this study will be used to intervene at the level of primary prevention. Subsequently, a prevention

program tailored to the needs of these outdoor workers will be developed.

CHAPTER II

Review of Literature

Introduction

The review of literature will focus on the acquisition of Lyme disease in select groups and will briefly describe the Lyme disease process itself, as well as laboratory testing as a diagnostic measure.

After reviewing the literature the epidemiological model will be discussed as it relates to the Lyme disease cycle.

Etiology and Symptomotology

Lyme disease was first investigated in the United States in 1975, when Steere and colleagues (1977) conducted a retrospective study of a unique group of children in Lyme, Connecticut who had been diagnosed with juvenile rheumatoid arthritis (Steere, Malowista, Snydman, 1977). In their study Steere et al. (1977) learned that most cases were clustered in 3 townships, occurred in the summer months, and generally in individuals who lived in heavily wooded areas. Additionally, the researchers found that 25% of the cases reported a skin rash which was originally described in 1909 by a Swedish physician, Arvid Afezelius, as erythema chronicum migrans (Habicht, et al., 1987). On the basis of Steere's findings, the researchers concluded that the disease was most likely caused by a virus and transmitted by an arthropod. Subsequently, the disease was called Lyme arthritis or Lyme disease.

In 1977, the tick responsible for causing Lyme disease was identified by Andrew Spielman after it had been saved by a patient who had experienced an erythema chronicum migrans (Wickelgren, 1989). The causative agent, the Borrelia burgdoferi, a spirochete was not identified until 1982, after researchers realized that the disease was sensitive to penicillin, a bactericidal agent (Steere, et al. 1983).

Health officials generally accept that Lyme disease occurs in three separate stages. Steere (1989) reports that Asbrink proposed a staging system similar to that of syphilis: early infection or stage one consisting of a localized skin rash; stage two or disseminated infection occurring weeks or months later with intermittent symptoms; and stage three beginning a year or more after the onset of the disease and being defined as a persistent infection (Steere, 1989).

Stage one of Lyme disease is generally characterized by the clinical marker erythema migrans. This skin rash begins as a macule or papule 4 to 20 days after the bite of a tick and enlarges to form an annular lesion with expanding red rings which have a bull's eye appearance. Common sites for erythema migrans include the thighs, buttocks, back, and axilla. Approximately 60% to 80% of the patients will experience this unique skin rash. The erythema migrans generally fades within 3 to 4 weeks, yet may re-occur for up to a year or more. The duration of

this stage is unclear as it may overlap with subsequent stages. Associated symptoms of stage one include fatigue, malaise, headache, and arthralgias.

Stage two is characterized by cardiac and neurological involvement. This stage may occur within weeks or months after the bite of a tick. Steere (1989) explains that the spirochete spreads via the patient's blood or lymph to many different sites. The most common cardiac problems identified include fluctuating degrees of atrioventricular block and acute mycopericarditis (Steere, 1989). The most common neurological problems include Bell's palsy, meningitis and cranial neuritis (Steere, 1989).

Finally, stage three occurs weeks or months after the bite of a tick. The classic manifestation for this stage is arthritis which most commonly affects the large joints, such as the knees. Stechenberg (1988) reports that the first episode of arthritis lasts about one week, yet recurrent attacks are not uncommon.

Treatment of Lyme disease is imperative to resolve the symptoms and arrest the disease process. Through research, health officials now believe that tetracycline is superior to penicillin as the drug of choice in treating early Lyme disease (Steere, 1989). In stages two and three, intravenous penicillin or ceftriaxone have been proven to be effective as well (Steere, 1989).

Diagnosis of Lyme Disease

Diagnosing Lyme disease can be difficult due to

the wide array of clinical symptoms individuals may manifest. Schwartz and Goldstein (1989) report that serological tests including indirect fluorescent antibody (IFA), enzyme-linked immunoassay (ELISA), immunoblotting, and antibody capture ELISA have proven to be useful in making the Lyme disease diagnosis. However, from reviewing the literature, the ELISA test appears to be the laboratory aid most often utilized. Similarly, the actual isolation of the spirochete from tissue, blood and spinal fluid permits a more definitive diagnosis, yet is less sensitive and is impractical for large volumes of testing (Schwartz and Goldstein, 1989).

Examining serological testing further, Magnarelli (1989), Russell, Sampson, Schmid, Wilkinson and Plikaytis (1984) and Steere et al. (1983) concur that the IgM antibody to the Borrelia burgdorferi spirochete usually rises in three to four weeks following the bite of an infected tick. Generally, this elevation persists for about one month until the IgG antibody rises, at which time the IgM will then decline. The IgG antibody level will often remain elevated for months or even years. However, Magnarelli (1989) indicates that successful antibiotic treatment will curtail elevated antibody titers.

The sensitivity of the ELISA method may be low during the initial weeks of infection and thus create a false negative result (Schwartz and Goldstein, 1989; Steere, 1989). Additionally, antibiotic treatment may diminish

detectable levels of antibody. In turn, the ELISA test allows opportunity for false positives to occur, as in the event of cross-reactivity such as a reactive syphilis serology, or another Borrelia organism (Steere, 1989; Magnarelli, (1989).

Of further interest is the concept of quantitative titers. Magnarelli (1989) explains:

> although antibody titers for a given specimen can vary two-fold or sometimes four-fold on different days of testing, there is value in determining titration end points. A relatively low antibody titer near the cut-off level for a positive result may indicate a non-specific reaction. High titer results are convincing evidence of prior or current Borrelia burgdorferi infection. Therefore, when serological tests results are reported, some indication of quantitation should be given (p.333).

The conclusion is reached that although serological testing for Lyme disease is useful as a laboratory aid, it must be used cautiously in terms of false reactions. Schwartz and Goldstein (1989) reiterate the following in regard to advantages and disadvantages of laboratory analysis:

- many patients treated early in the disease will not develop measurable antibodies,
- the antibody testing is very sensitive for stages two and three, approaching 95%,

- cross-reactivity may occur,
- methods in different laboratories have not been standardized,
- ELISA is generally a better test because of sensitivity and specificity and easier automation (p.737).

Studies in Select Populations

From 1978 to 1982, Bowen, Schulze, Hayne and Parker (1984) investigated cases of Lyme disease in the state of New Jersey. During this period, 117 cases were reported in the state. However, an interesting finding was that 57 cases were clustered in the east central county of Monmouth.

Bowen et al. (1984) defined a case as (a) erythema chronicum migrans, either alone or accompanied by other symptoms, documented by examination by a physician or unequivocal history of the patient during a direct interview with authors, (b) large joint, inflammatory, migratory arthritis without etiology, after rheumatology diagnostic work-up and within four months of the tick bite, (c) Bell's palsy within two months of tick or insect bite, (d) indirect fluorescent antibody titer greater than or equal to 1:256 in serum collected at least one month after the onset of illness in a patient with clinically compatible illness (p. 388). All cases were verified by telephone, personal interview and when possible a review of the patients medical record.

In studying cases of Lyme disease in Monmouth County, Bowen found that 57 cases were clustered around four townships. They were Colt's Neck, Howell, Freehold, and Wall, which were all in close proximity to each other. Another identifiable characteristic was that 30 of the 57 cases were reported by persons who worked at a military facility known as Naval Weapons Station, Earle.

In studying the 30 cases of Lyme disease at the Naval Weapons Station, Bowen et al.(1984) divided the cases into two categories. They were indoor and outdoor workers. Indoor workers were defined as workers spending all of their time in an office or outdoor movement in between offices on paved areas or mowed lawns. Outdoor workers were defined as workers who had regular contact with the woods, brush or tall grass away from the paved areas and mowed lawns. Bowen et al. (1984) found that the incidence of Lyme disease was significantly higher for persons working outdoors, rather then indoors. There was no statistically significant difference in the incidence of Lyme disease between the various occupational groups within the category of outdoor workers.

In conclusion, Bowens et al. (1984) study found that during 1980-1982, Monmouth County had the highest annual incidence (3.8/100,000) of Lyme disease in the state of New Jersey. He commented that the increased incidence was probably due to greater reporting, better recognition of the illness and increases in population in endemic areas.

Bowen et al.(1984) also noted that the larger number of cases at the Naval Weapons Station was due in part to the higher proportion of outdoor workers, the necessity to seek medical care on military bases, and the fact that the environment included wooded areas and wildlife within a fenced area.

In looking at focal endemic areas, Hanrahan, Benach, Coleman, Bosler, Morse, Cameron, Edelman, and Kaslow (1984) conducted a prospective study of residents in a community on Fire Island in New York where 14 cases of Lyme disease had been reported in residents between 1979 and 1981. Fire Island is similar to Assateague Island, Maryland in that it is a barrier island which is inhabited by the white-tailed deer and the white-footed mice. The population of the community studied was 600-1000 people excluding the summer tourists.

In 1982, Hanrahan and colleagues (1984) met with the residents of this community on Fire Island to discuss the study. At this time, the researchers administered a questionnaire seeking demographic information, data on time spent outdoors and signs and symptoms of Lyme disease. Additionally, a blood specimen was collected for detection of Lyme disease antibody by indirect immunofluorescence.

Hanrahan et al. (1984) began the study with 200 subjects. Of this number, 15 (7.5%) reported a history of <u>erythema migrans</u> between 1977 and 1982. One hundred seventy six participants elected to have their blood

tested. Of the individuals tested for the presence of Lyme disease antibodies, 17 (9.7%) showed a positive IgG titer greater than 1:64. Six (40%) of the original 15 individuals reporting a history of erythema migrans had IgG titers greater than 1:64. The remaining 11 elevated titers were from participants who reported no clinical history of Lyme disease. Hanrahan and colleagues (1984) found no association between seropositivity and time spent outdoors, age, sex, or number of summers spent on Fire Island.

In looking at seroconversion, Hanrahan et al. (1984) repeated the blood specimens and questionnaires during the end of the summer season. Of the 176 originally tested, 124 (70.4%) returned to participate. Two of these individuals exhibited clinical cases of Lyme disease and demonstrated a rise in titer from an original non-reactive specimen. Additionally, two other subjects exhibited a four fold rise in IgG titers yet did not display clinical evidence of Lyme disease.

Hanrahan's study suggested that subclinical cases or asymptomatic seroconversion may occur in individuals exposed to Borrelia burgdoferi. Also discussed were the unique features of Fire Island which may contribute to the prevalence of Lyme disease. These factors included a large deer population which has little fear of the human population since hunting is prohibited, increased outdoor activity among the human population with less protective clothing, and small ticks which are difficult to

distinguish by the naked eye.

Similar to Hanrahan's et al. (1984) study, Steere, Taylor, Wilson, Levine and Spielman (1986) conducted a five year prospective study of the epidemiological features of Lyme disease among residents of Great Island in Massachussetts from the years 1979 to 1983. Great Island is on the shore of Cape Cod and is connected to the mainland by a bridge. The island is heavily wooded, has sandy beaches and is inhabited by the white-tailed deer and white-footed mice, Additionally, Ixodes dammini ticks have been identified.

Steere and colleagues (1986) enrolled 162 residents who had lived on Great island long term, yet on a summertime basis. As with the methodology of former studies, Steere et al. (1986) administered a questionnaire and collected a venous sample for Borrelia burgdorferi antibody detection. However, much of the serum had to be frozen until serological testing by ELISA technique became feasible for screening in 1983.

Steere et al. (1986) defined a case of Lyme disease as a) an erythema migrans, possibly followed by neurological, cardiac or joint abnormalities, b) a "flu-like" illness during the summer followed by arthritis, c) a series of brief oligarticular arthritis not due to other known causes (p 296).

The researchers discovered the first case of Lyme disease occurred in 1962 in a 35 year old female who

had experienced intermittent attacks of arthritis for 15 years. This participant had an extremely elevated IgG antibody response and had never been treated with antibiotics. Tests specific to rheumatoid arthritis had been ruled negative. Steere et al. (1986) also found that of the 162 residents , 26 (16%) had acquired Lyme disease at some point in time. Out of this number sixteen were symptomatic cases and ten were asymptomatic.

In another select population, Smith, Benach, White, Stroup and Morse (1988) conducted a study to determine seropositivity for Lyme disease in outdoor workers and assessed occupational and leisure activities as risk factors for this infection. The researchers studied employees of Fire Island National Seashore near Long Island, New York in 1986. As with the surroundings in Steere's (1986) study, the employees worked in areas inhabited by the white-tailed deer and white-footed mice.

Smith et al. (1988) recruited 414 participants for their study. A self-administered questionnaire was used to gain information on months or years of employment, amount of time spent outdoors at work and at leisure, specific outdoor habitats at work and at leisure, tick exposure at work and at leisure during the past year, and precautions used to avoid ticks. A venous blood sample was collected on two separate occasions, 3 to 6 months apart, to determine seroconversion. Two additional groups were

used for controls. They were blood donors in an endemic county and blood specimens sent to the New York State Health Department for syphilis serology testing.

Based on data from the first questionnaire and laboratory testing, Smith et. al (1988) found that 322 (78%) of the participants were male and 392 (95%) were white. Ages ranged from 17 to 76 years. Ninety-three percent of the participants worked outdoors on the job part of the time. Nine participants had a past history of Lyme disease.

Through laboratory analysis, Smith et al. (1988) learned that 27(9%) participants had detectable antibodies to Borrelia burgdorferi. Older participants had a higher rate of seropositivity than did younger participants. Fourteen participants gave a history of one or more symptoms of Lyme disease.

In looking at tick bite exposure, 4 (57%) of the seropositive individuals gave a history of more than 4 tick bites during the past year. However, out of 107 individuals reporting at least one tick bite per week during leisure activities, 12 (11.2%) were seropositive. Preventive behaviors practiced to avoid tick exposure were not associated with antibody status.

In conclusion, Smith et al. (1988) found that workers who spent more than 30 hours per week outdoors during leisure activity were more likely to be seropositive than those who did not. There was no association between

seropositivity and time spent outdoors during work hours. Additionally, there was no association between leisure activity and outdoor habitats, such as mowed lawn or woodlands. Seropositivity was also associated with the number of tick bites during leisure activity, yet seropositivity was not associated with hours of leisure activity per week.

In a similar study Neubert, Munchoff, Volker, Reimers, and Pfluger (1988) looked at the extent Bavariian Forest Workers, by virtue of occupational exposure to ticks, would exhibit clinical or serological evidence of Lyme disease. In 1983, 211 workers in Upper Bavaria were clinically examined and serologically tested by indirect immunofluorescence for Lyme disease antibodies. Out of 211 subjects, 71 (34%) tested seropositive. Interestingly, seropositivity rose with age. The age range was 17-68 with a median of 49 years. There were slight differences between seropositives and seronegatives in terms of tick bite history and symptoms of Lyme disease. For example, some seropositives experienced a history of cardiac symptoms as opposed to seronegatives who did not.

In 1986, two and one half years later, Neubert et al. (1988) re-examined and retested 53 of the initial 71 forestry workers who were seropositive and left untreated. Out of the 53 subjects retested, 33 (62%) forestry workers showed a four fold decrease in IgG titers, and 20 (38%) forestry workers did not show a significant difference in

titers. Furthermore, 37 (70%) individuals displayed no signs and symptoms of Lyme disease, 14 (26%) individuals experienced symptomotology of Lyme disease and 2 (4%) individuals were reported as equivocal. These findings led Neubert et al. (1988) to believe some cases of Lyme disease may be self healing, yet he suggested when symptoms heighten, treatment may be necessary.

In another study, Aeschlemann, Gern, Zhioua, Frossard, Walter, Fahrer, Sauvain, Van Den Linden, and Gerber (1989) studied two groups of individuals considered to be "at risk" for Lyme disease. They were sportsmen who spent a considerable amount of time running in the forest, and a segment of the population from rural Aarberg in Switzerland who were asymptomatic of Lyme disease.

Aeschlemann's et al. (1989) methodology consisted of blood sampling and the administration of a questionnaire. Five hundred sixty five sportsmen had blood specimens drawn twice during 1986 to determine the presence of Lyme disease antibodies. The laboratory tests used were the indirect immunofluorescence test for sample one and enzyme-linked immunosorbent assay for samples one and two. Additionally, the sportsmen responded to a questionnaire regarding their training habits, history of tick bites, and Lyme disease symptomotology. The rural population studied consisted of 491 persons entering the hospital of Aarberg.

Aeschlimann's et al. (1989) study suggested that many individuals may have subclinical cases of Lyme

disease. Of the sportsmen tested on two occasions, 565 (69%) remained negative, 16% remained positive, 11% seroconverted to positive and 4% reverted to negative. Equally important, of the 491 asymptomatic hospital patients in Aarberg, 26.6% had positive IgG titers. Aeschlimann et al. (1989) concluded by stating that rural lifestyles compounded with the unawareness of being bitten by a tick may account for the nonapparent infections with the spirochete known to cause Lyme disease.

As with Neubert's (1988) and Aeschlimann's (1989) studies, Guy, Martyn, Bateman, and Heckels (1989) examined the serum of 41 forestry workers. The researchers found that 10 (25%) workers had antibodies to Borrelia burgdoferi, despite the fact that only two workers reported symptoms of Lyme disease. These results also led Guy (1989) to conclude that some individuals may experience subclinical cases of Lyme disease.

Building upon existing studies, Schwartz, Ribeiro, and Goldstein (1990) conducted a cross-sectional study of seropositive outdoor workers employed by The New Jersey State Department of Environmental Protection. The purpose of the study was to evaluate the risk associated with occupational exposure to ticks, occupational and leisure activities, preventive practices, and tick removal methods (Schwartz, Ribeiro and Goldstein, 1990, pg. 879).

Similar to the methodology of other studies (Bowen et

al. 1984; Neubert et al. 1988; Aeschlimann et al. 1988; Guy et al. 1989; Smith et al. 1988; and Hanrahan et al. 1984), Schwartz, Ribeiro, and Goldstein (1990) relied on self reporting through the administration of a questionnaire and the collection of a venous blood sample for antibody detection. However, not only did the researchers examine for antibodies to Borrelia burgdorferi but they also looked for anti-arthropod salivary gland protein antibodies, such as Ixodes dammini. The questionnaire requested information on previous signs and symptoms of Lyme disease, the use of medications, tick bite exposure, and the amount of time spent outdoors. Serological analysis was conducted by three separate laboratories. Two laboratories performed enzyme-linked immunosorbent assays and one performed indirect fluorescent antibody tests. Schwartz, Ribeiro and Goldstein (1990) defined a positive antibody test as one which was positive in at least two separate labs.

The researchers enrolled 689 workers into their study. Of this number, 39 (5.7%) met the definition of a positive Borrelia burgdorferi antibody test. Interestingly, in comparing seronegatives to seropositives, the study found that there were more positive males who had fewer years of employment and less self-reported medical problems. There were no significant differences between seropositives and seronegatives in job titles and pet ownership. However, statistically significant differences were noted between the two groups related to certain leisure activities, such

as hunting, hiking, and fishing. Additionally, the majority of seropositives resided in a rural area. Schwartz, Ribeiro and Goldstein (1990) could not correlate the number of self-reported tick bites to Borrelia burgdorferi antibody levels. Yet, they did find that seropositive individuals had a higher level of anti-arthropod antibodies then seronegatives.

In conclusion, they comment that tick bite exposure needs to be further investigated. They suggest a need for tick bite duration and Borrelia burgdorferi antibody correlation, as well as Ixodes dammini antibody levels as a predictor of risk for Lyme disease.

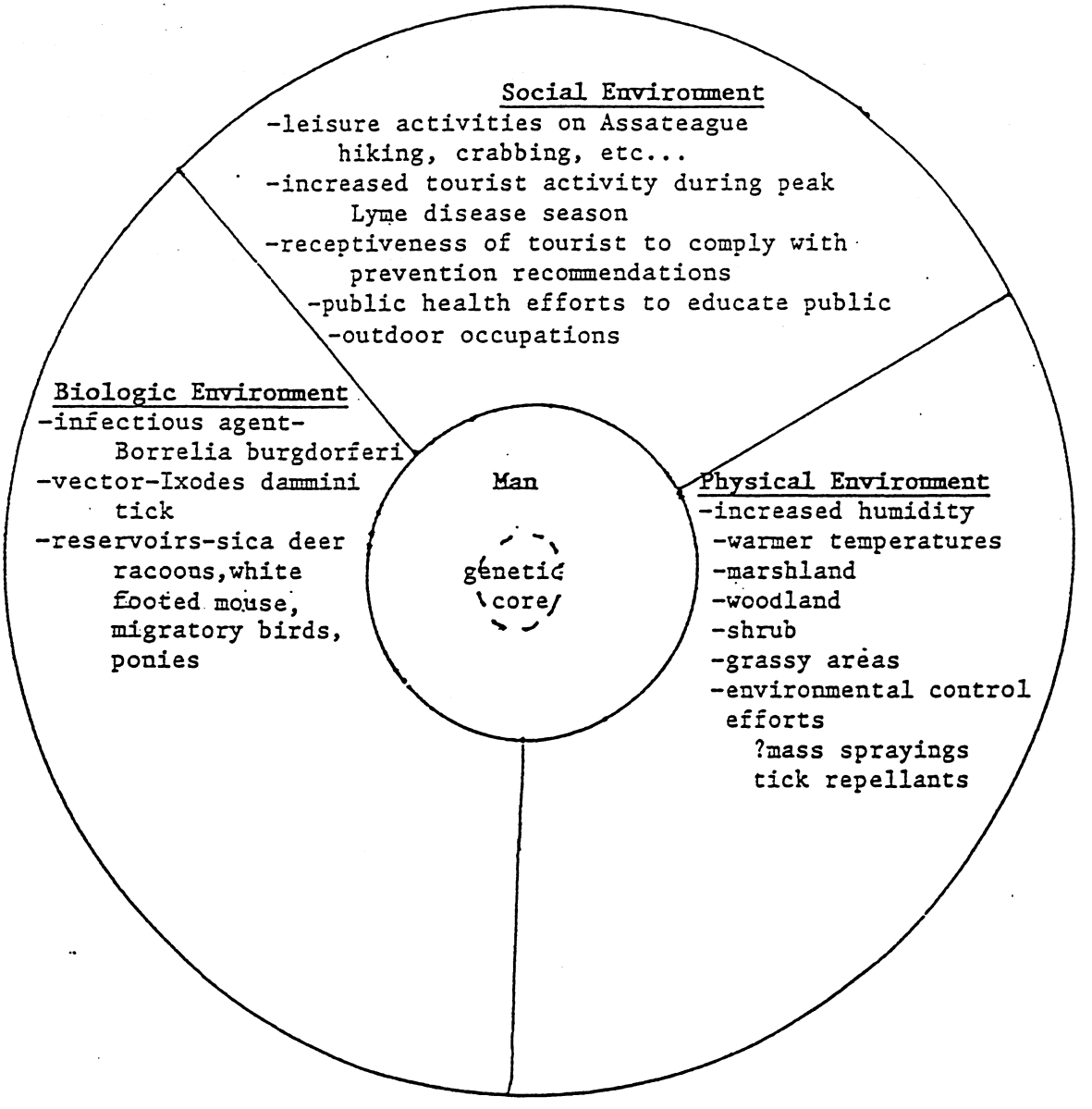
Application of The Wheel Epidemiological Model to Lyme Disease

In controlling the occurrence of Lyme disease, it is important to understand the relationship of the host, which is man, and his interaction with the environment. The wheel is an epidemiological model which depicts human-environment relations in terms of disease causation (Mausner and Bahn, 1985). Integrating the three subdivisions allows the researcher to analyze the data completely, and develop strategies for the control of the disease. The wheel is divided into three sections with a genetic core (Figure 1). The three sections include biological, social, and physical factors. However, the proportion of the section varies with individual illnesses, such that an environmental factor would have a larger

Figure 1

THE WHEEL

Epidemiological Model For Lyme Disease



physical component.

In applying the model of the wheel to Lyme disease, the sections become evenly divided. The genetic core is small, as the genetic make up of man has relatively little to do with the acquisition of Lyme disease. The biologic environment is the section which includes (a) infectious agents of disease, (b) reservoirs of infection, (c) vectors that transmit disease, (d) plants and animals (Mausner and Bahn, 1985, p. 30). For Lyme disease, this includes the Borrelia burgdorferi spirochete as the infectious agent, the Ixodes dammini tick as the vector, and sica deer, raccoons, white-footed mice, migratory birds, foxes, and ponies as reservoirs.

The social environment is defined as the economic and political organization of a society which affects health. Factors which apply to Lyme disease on Assateague Island include leisure activities such as crabbing and hiking, increased tourist activity during the peak Lyme disease season, the receptiveness of tourists to comply with preventive practices, and public health efforts to educate the public and outdoor workers.

The physical environment is defined as the aspects which include heat, light, air, water, radiation, gravity, atmospheric pressure, and chemical agents (Mausner and Bahn, 1985, p. 31). The factors in this section which affect the causation and control of Lyme disease include increased humidity, warmer temperatures, marshland,

woodland, grassy areas, shrubs, and mass control efforts.

In the Assateague Island study, the model of the wheel will be applied to integrate the three subdivisions and develop control strategies for the prevention of Lyme disease on this barrier island.

Summary of Review of Literature

A review of the literature demonstrates variability within studies that have looked at the acquisition of Lyme disease in select populations. Although, Bowen et al. (1984), Neubert et al. (1988), Guy et al. (1989), and Schwartz et al. (1990) suggest there is an occupational risk of Lyme disease in outdoor workers, Smith's et al. (1988) study did not support these findings, they found that individuals were more likely to acquire Lyme disease through leisure activities rather than work-related activities. Hanrahan et al. (1984) and Steere et al. (1986) looked at island communities and also found that areas which were inhabited by the white-tailed deer, white-footed mice, and Ixodes dammini tick placed residents at a greater risk of acquiring Lyme disease than control groups in non-endemic areas.

A common denominator to all studies was the presence of subclinical or asymptomatic cases of Lyme disease. In fact, Aeschelmann et al. (1989), who studied 491 asymptomatic hospital patients, found that 26.6% were positive for the Borrelia burgdorferi antibody.

In looking at the design and methodology of the

studies there were many similarities. For the most part, the studies were prospective in design and examined select populations. Generally, the subjects responded to a self-administered questionnaire specific to Lyme disease symptomotology and tick exposure and were requested to submit a venous blood sample for Borrelia burgdorferi antibody detection.

Common criticisms of the studies include inconsistencies with self-reporting, difficulty in obtaining accurate data on tick exposure due to the small size of the Ixodes dammini tick, lack of standardization in Lyme disease testing, and inadequate time between specimen collection to determine seroconversion.

In conclusion, the literature indicates the need for further epidemiological studies of Lyme disease in select populations. Future studies which would examine subclinical cases, tick bite exposure, and preventive behavioral practices would be beneficial in impacting upon the control of this illness.

Chapter III

Methodology

Introduction

This chapter discusses the study methodology. The design and major variables are described, and the research questions posed.

Purpose of Study

The purpose of this study was to assess the occupational risk of Lyme disease in workers within the Assateague Island State and National Seashore Park in Maryland, by identifying seroconversion, examining tick bite exposure and assessing preventive behavioral practices.

Analysis of these findings will be used to intervene at the level of primary prevention. Subsequently, a prevention program tailored to the needs of these workers will be developed.

Study Design

The research project was a prospective epidemiological study. Participants were followed for five consecutive months. The aim was to assess tick bite exposure and seroconversion, and thus examine the relationship between these two variables and preventive behavioral practices.

Research Questions

1. What is the relationship between work assignment and tick bites experienced?
2. What is the relationship between work site locations,

time spent in those sites and the number of tick bites experienced?

3. Did seasonal workers experience more tick bites than permanent workers?
4. Will outdoor workers experience a higher rate of seropositivity than indoor workers?
5. What is the relationship between preventive behaviors practiced and the number of tick bites experienced?

Null Hypotheses

1. There will be no significant difference in the number of tick bites experienced and the time spent outdoors on the job.
2. There will be no significant relationship between the work site location (mowed lawn, meadow, marsh shrubs, paved areas, sand beaches and woodland) time spent in those areas and the number of tick bites experienced.
3. There will be no significant difference in the number of tick bites reported by seasonal workers and permanent workers.
4. There will be no significant difference in seropositivity rates between indoor workers and outdoor workers.
5. There will be no significant relationship between preventive behavior practiced and the number of tick bites experienced.

Major Study Variables

The major dependent variable was tick bite exposure.

The major independent variables were work site location, time spent in those areas, and preventive behaviors practiced.

Major Dependent Variable

Tick bite exposure.

Tick bite exposure was based on self-report of the number of tick bites on the study questionnaire. The question was asked whether the subject had experienced any tick bites during the past year. If yes, subjects could respond based on four categories, which were: 1-10 tick bites, 11-30 tick bites, 31-100 tick bites, and more than 100 tick bites.

Seropositivity. This refers to a serum specimen measuring a quantitation of IgM and IgG antibodies, which are developed in response to the *Borrelia burgdorferi* spirochete. The criteria for seropositivity was delineated as greater than 1.00, by the enzyme-linked immunosorbent assay test.

Major Independent Variables

Work Site Location.

Work site location was based on self-report of the study questionnaire. The question assessed the amount of time participants spent at work and at leisure, in each of the following areas: marsh, meadow, mowed lawn, paved areas, sand beach, shrub growth and woodland. The categories to measure time were: 0 hours, 1-10 hours, 11-30

hours, and over 30 hours.

Work Assignment.

Work assignment was based on self report of the study questionnaire. The question assessed the amount of time spent outdoors during working hours. The categories were as follows: 100% indoor work, 100% outdoor work, 75% outdoor work, 50% outdoor work, and 25% outdoor work.

Employment Status.

Employment status was based on self report of the study questionnaire. Participants were asked to specify their job status based on four categories which were: permanent, seasonal, volunteer or other.

Preventive Behaviors.

Preventive behaviors were determined by self-report. The question assessed the behaviors which participants practiced at work and at leisure to prevent tick bites. The categories were as follows: wore light colored clothes, wore long pants, tucked pants into socks, wore long sleeve shirts, wore a hat, used insect repellant on skin, used insect repellant on clothing, used permanone on clothing, and checked yourself for ticks. Respondents were asked to indicate the preventive measures taken to avoid tick bites, on and off the job.

Study Population

The study population consisted of all Assateague Island State and National Seashore Park employees. The park employs approximately 45 permanent workers and 110

seasonal workers.

Study Sample

The study sample included all of those in the study population who agreed to participate. All indoor and outdoor workers were eligible to participate. An overview of the study was provided at a general orientation session for the employees.

Instrumentation

The questionnaires used were developed by an epidemiologist at the Maryland Department of Health and Mental Hygiene and were modeled after the instruments used in Smith's (1988) study.

The first questionnaire, which was administered during May and June (Phase I), contained 22 questions. Questions 1 through 7 dealt with demographic data. Questions 8 through 15 requested data about years of employment, work assignment, and employment status. Question 16 assessed the subjects participation in leisure activity, and questions 17 through 22 dealt with tick bite exposure and Lyme disease symptomatology.

The second questionnaire was administered during August, September, and October (Phase II). This questionnaire was slightly different from the first questionnaire, in that specific questions were asked in regards to the number of hours spent outdoors in certain geographical areas on and off the job, as well as preventive behavioral practices used to avoid tick bites.

Questions 1 through 6 dealt with employment data, 7 through 10 assessed the length of time spent outdoors, and time spent in specific geographical areas during work and leisure, and finally 11 through 16 dealt with tick bite exposure, preventive behaviors practiced, and Lyme disease symptomatology. Refer to the appendix for copies of the questionnaires.

Data Collection

Employees of Assateague Island State and National Seashore Park were given an overview of the study at a general orientation session; confidentiality, informed consent, and voluntary participation were stressed. Additionally, this session consisted of a one hour slide presentation on Lyme disease, its clinical manifestations, diagnosis, treatment and prevention. Participant recruitment for the study began May 23, 1989 and ended June 30, 1989.

Phase II of the project began in August 1989 and ended in October 1989. Ninety-five percent of the data collection was done on-site at Assateague Island by the nurse researcher. The remaining five percent was collected at the Worcester County Health department in Berlin, Maryland. Generally, participants were given 15 minutes to complete each questionnaire.

Assumptions

1. Lyme disease is a serious illness which requires treatment to arrest the disease process.

2. Preventive behavior is the key to avoiding Lyme disease.

Limitations

1. Some participants may have had an inadequate amount of time between the first and second blood specimen collection to detect seroconversion. Shrestna and colleagues (1985) report that the IgM titer may not peak for six weeks after the onset of disease, and IgG several months later.
2. The questionnaire administered was based on self-reporting, which could lead to inconsistencies in data collection.
3. Participants' leisure activities may place them at greater risk than their actual job responsibility.
4. Antibiotic treatment in early Lyme disease may prevent seroconversion.

CHAPTER IV

Data Analysis

Introduction

The purpose of the study was to assess the occupational risk of acquiring Lyme disease within the endemic area of Assateague Island, which is on the Eastern Shore of Maryland. Specifically, the researcher examined seroconversion, tick bite exposure and preventive behavioral practices used to avoid Lyme disease.

Within this chapter, the study sample will be described as well as the relationship between work site location and tick bite exposure. The relationship between employment status and tick bite exposure will be examined as will the use of behavioral practices.

Sample Characteristics

Assateague Island State and National Seashore Park employs approximately one hundred fifty five individuals. Generally, forty five are permanent and one hundred ten are seasonal employees. All employees of the park were eligible to participate in this study on a voluntary basis.

Phase I of the study, which consisted of the administration of the first questionnaire and a baseline venous sample for *Borrelia burgdorferi* antibody detection, was comprised of ninety nine subjects (Table 1). Thirty five (35.4%) employees were female and sixty four (64.6%) were male. The age range was from sixteen to seventy seven years of age, with a mean of thirty four years. Thirty one

Table 1

Characteristics of the Sample

Phase I

	Number of Responses (n=99)	Percentage
Age		
16-20	15	15.2
21-30	31	31.3
31-40	25	25.2
41-50	15	15.2
51-60	6	6.0
61-70	5	5.1
71 and older	2	2.0
Total	99	100.0
Sex		
Male	64	64.6
Female	35	35.4
Total	99	100.0
Employment Status		
Permanent	31	31.3
Seasonal	52	52.5
Volunteer	10	10.1
Other	6	6.1
Total	99	100.0

	Number of Responses (n=99)	Percentage
Years of Employment		
Less than 1 year	31	31.3
1-4 years	41	41.4
5 years or more	27	27.3
Total	99	100.0
Expected Work Assignment		
100% Indoor	3	3.0
100% Outdoor	42	42.4
75% Outdoor	18	18.2
50% Outdoor	13	13.1
25% Outdoor	17	17.2
Don't Know	6	6.1
Total	99	100.0

(31.3%) were permanent workers and fifty two (52.5%) were seasonal workers. Sixteen (16.2%) were either volunteers or listed as other. Thirty one (31.3%) of the participants had worked less than one year for Assateague Island State and National Seashore Park. Forty one (41.4%) had worked 1 to 4 years, and 27 (27.3%) worked 5 years or more. Forty two (42.4%) expected to work outdoors 100% of the time, eighteen (18.2%) 75% of the time, thirteen (13.1%) 50% of the time, seventeen (17.2%) 25% of the time and three (3.0%) indoors 100% of the time. Six (6.1%) did not know their expected work assignment. There were no study participants who had a prior diagnosis of Lyme disease. However, sixty nine (69.6%) reported a tick bite within the last five years.

Phase II of the study began 3 months after the beginning of Phase I. This phase consisted of the administration of a second questionnaire and a repeat venous blood sample. There were eighty six participants enrolled in Phase II (Table 2). Out of this number, fifty three (61.6%) subjects were male and thirty three (38.4%) were female. It is believed that the thirteen missing participants were seasonal employees who left prior to completion of the study.

In Phase II of the study, thirty two (37.2%) participants actually worked outdoors 100% of the time. Nineteen (22.1%) participants worked outdoors 75% of the time; fourteen (16.3%) 50% of the time, and thirteen

Table 2

Characteristics of Sample

Phase II

	Number of Responses (n=86)	Percentage
Sex		
Male	53	61.6
Female	33	38.4
	86	100.0
Work Assignment		
100% Indoor	6	7.0
100% Outdoor	32	37.2
75% Outdoor	19	22.1
50% Outdoor	14	16.3
25% Outdoor	13	15.1
Don't Know	2	2.3
	86	100.0
Employment Status		
Permanent	32	37.2
Seasonal	43	50.0
Volunteer	8	9.3
Other	3	3.5
	86	100.0

(15.1%) 25% of the time. Six (7%) participants worked indoors 100% of the time and two (2.3%) did not know their work assignment category.

Thirty two (37.2%) of the subjects were permanent employees. Forty three (50%) of the subjects were seasonal employees and eight (9.3%) were volunteers. Three (3.5%) participants were listed as other which primarily included student researchers.

Finally, fifty seven (66.3%) of the study participants reported a tick bite during the study period. Forty six (53.5%) reported 1-10 tick bites, seven (8.1%) reported 11-30 tick bites, and four (4.7%) reported 31-100 tick bites.

Relationship of Work Site Location and Tick Bite Exposure

The relationship of work site location and tick bite exposure was of interest to the researcher as it was thought that the distribution of ticks may be higher in certain work areas, such as marsh, woodland, mowed lawn, shrubs and meadow.

Therefore, to examine the relationship of tick bite exposure and work site location, a chi square was performed for each work area listed on questionnaire number two. Prior to the analysis, the data was collapsed to avoid small cell sizes. The dependent variable, tick bite exposure was reduced to two categories which were: 0-10 tick bites and 11-100 tick bites. The independent variable, time spent in each work site location (mowed lawn, meadow, shrubs, paved areas, sand beaches, woodland

and marsh) was collapsed into two categories which were: 0 hours, and 1 to 30+ hours (Tables 3,4,5,6,7,8,9).

Results indicated that individuals who worked on the marsh experienced a greater number of tick bites (Table 3). Additionally, there was a trend suggesting that workers who spent more time in the woodlands experienced a greater number of tick bites (Table 4). There was no significant difference in time spent in the mowed lawns, shrubs, sand beaches, paved areas, or meadow and the number of tick bites experienced (Tables 5,6,7,8,9).

Relationship of Work Assignment to Tick Bite Exposure

The relationship of work assignment and tick bite exposure, specifically time spent outdoors on the job, was examined to determine if individuals who spent a larger percentage of their time outdoors acquired more tick bites than those individuals who spent less time outdoors.

A chi square test was performed to gain information about the relationship of tick bite exposure and work assignment. Once again, the data was collapsed to eliminate small cell sizes. Tick bite exposure was reduced to the same two categories as previously described. Work assignment was collapsed from four categories into two, which were: less than 75% of the time outdoors, and 75% or more of the time spent outdoors, on the job.

Results indicated that there was no significant difference in tick bite exposure related to the amount of time spent outdoors on the job (Table 10).

Table 3

The Relationship of Time in Marsh to Tick Bite Exposure

		0 - 10	11 - 100	Bites
Time in Marsh	0 Hrs.	43	2	45 (53.6)
	1-30+ Hrs.	30	9	39 (46.4)
		73 (86.9)	11 (13.1)	84 (100.0)

chi-square	value	df	significance
Pearson	6.37356	1	0.01158

Table 4

The Relationship of Time in Woodland to Tick Bite Exposure

Time in Woodland	0 - 10	11 - 100	Bites
0 Hrs.	54	5	59 (70.2)
1-30+ Hrs.	19	6	25 (29.8)
	73 (86.9)	11 (13.1)	84 (100.0)

chi-square	value	df	significance
Pearson	3.71914	1	0.05379

Table 5

The Relationship of Time in Shrubs to Tick Bite Exposure

		0 - 10	11 - 100	Bites
Time in Shrubs	0 Hrs.	20	5	25 (29.8)
	1-30+ Hrs.	53	6	59 (70.2)
		73 (86.9)	11 (13.1)	84 (100.0)

chi-square	value	df	significance
Pearson	1.49110	1	0.22205

Table 6

The Relationship of Time on Sand Beach to Tick Bite Exposure

		0 - 10	11 - 100	Bites
Time on Sand Beach	0 Hrs.	17	1	18 (21.4)
	1-30+ Hrs.	56	10	66 (78.6)
		73 (86.9)	11 (13.1)	84 (100.0)

chi-square	value	df	significance
Pearson	1.14434	1	.28474

Table 7

The Relationship of Time on Paved Areas to Tick Bite Exposure

		0 - 10	11 - 100	Bites
Time On Paved Areas	0 Hrs.	19	2	21 (79.8)
	1-30+ Hrs.	54	9	63 (75.0)
		73 (86.9)	11 (13.1)	84 (100.0)

chi-square	value	df	significance
Pearson	.31382	1	.57534

Table 8

The Relationship of Time on Mowed Lawn to Tick Bite Exposure

		0 - 10	11 - 100	Bites
Time On Mowed Lawn	0 Hrs.	30	7	37 (44.0)
	1-30+ Hrs.	43	4	47 (56.0)
		73 (86.9)	11 (13.1)	84 (100.0)

chi-square	value	df	significance
Pearson	1.9707	1	0.16037

Table 9

The Relationship of Time in Meadow to Tick Bite Exposure

		0 - 10	11 - 100	Bites
Time in Meadow	0 Hrs.	56	11	67 (79.8)
	1-30+ Hrs.	17	0	17 (20.2)
		73 (86.9)	11 (13.1)	84 (100.0)

chi-square	value	df	significance
Pearson	.321161	1	.07312

Table 10

The Relationship of Work Assignment to Tick Bite Exposure

		0 - 10	11 - 100	Bites
Work Assignment	75% or more	44	7	51 (59.3)
	less than 75%	31	4	35 (40.7)
		73 (86.9)	11 (13.1)	84 (100.0)

chi-square	value	df	significance
Pearson	.09817	1	.75404

Relationship of Employment Status to Tick Bite Exposure

The relationship of tick bite exposure and employment status was of interest to determine if permanent employees experienced fewer tick bites than seasonal employees. One might expect that permanent workers may experience fewer tick bites due to their familiarity with the environment and preventive measures.

A chi square test was performed to determine the relationship of tick bite exposure and employment status. Again, the tick bite exposure category was reduced to two categories which were: 0-10 tick bites, and 11-100 tick bites. Employment status was collapsed from four categories into two which were: seasonal, volunteer and other into one group, and permanent workers into another (Table 11).

The results indicated that there was no significant difference in the number of tick bites experienced related to employment status.

Seropositivity in Outdoor Workers

From a review of the literature, it is clear that individuals may be at risk of acquiring Lyme disease in endemic areas by virtue of their outdoor occupation. Therefore, the identification of seropositivity or seroconversion was examined to gain a clearer understanding of the occupational risk of acquiring Lyme disease on Assateague Island.

The Lyme Stat Kit used for Borrelia burgdorferi

Table 11

The Relationship of Employment Status to Tick Bite Exposure

		0 - 10	11 - 100	Bites
Employment Status	Perm.	29	46	75 (87.2)
	Seas. Vol. Other	3	8	11 (12.8)
		32 (37.2)	54 (62.8)	86 (100.0)

chi-square	value	df	significance
Pearson	0.53304	1	0.46533

antibody detection, was the test used for identification of seropositivity. The blood specimens were sent to the State Laboratory Administration through the Department of Health and Mental Hygiene in Baltimore, Maryland.

During Phase I, ninety-nine blood specimens were submitted for Borrelia burgdorferi antibody detection. The results ranged from 0.0 to 0.6 (Table 12). A positive was considered to be 1.0 or greater, and a suspicious specimen from .80 to .99.

In Phase II, eighty-six blood specimens were submitted to the laboratory for seropositivity identification. During this phase, the results ranged from 0.0 to 0.7 (Table 13).

The Relationship of Preventive Behaviors Practiced to Tick Bite Exposure

The role of preventive behaviors is of interest when examining the number of tick bites experienced by an individual. In Phase II of the Assateague Island study, individuals were asked to respond with a 'yes' or 'no' answer to eighteen specific behaviors which could reduce the number of tick bites experienced. Each positive response on the questionnaire was given a score of one point, yielding a range of zero to eighteen points'.

In analyzing the data, the score for preventive behaviors ranged from one point to fifteen points, with the mean equalling 6.45.

A t-test was performed to examine the relationship between the number of preventive measures which workers used to

Table 12

Phase I

Frequencies of Lyme Disease Titers

Titer	Number of Responses (n=99)	Percentage
0.0	7	7.1
0.05	4	4.0
0.06	5	5.1
0.1	12	12.1
0.11	2	2.0
0.15	1	1.0
0.2	31	31.3
0.21	12	12.1
0.27	5	5.1
0.3	7	7.1
0.34	4	4.0
0.4	7	7.1
0.53	1	1.0
0.6	1	1.0
Total	99	100.0

Table 13

Phase II

Frequencies of Lyme disease titers

Titer	Number of Responses (n=86)	Percentage
0.0	24	27.9
0.04	1	1.2
0.05	1	1.2
0.07	5	5.8
0.08	7	8.1
0.09	1	1.2
0.12	1	1.2
0.16	2	2.3
0.18	4	4.7
0.19	4	4.7
0.20	2	2.3
0.23	8	9.3
0.30	5	5.8
0.32	1	1.2
0.37	1	1.2
0.39	1	1.2
0.40	1	1.2
0.41	1	1.2
0.42	1	1.2
0.50	1	1.2
0.6	2	2.3
0.7	1	1.2
Total	86	100.0

avoid tick bite exposure and the actual number of tick bites experienced.

The results indicated that there was no significant difference in tick bite exposure related to the number of preventive behaviors practiced by workers (Table 14).

Table 14

Relationship Between Preventive Behaviors Practiced and Tick Bite Exposure

Variable	Number of Cases	Mean	Standard Deviation	df	t-value
1-10 tick bites	75	6.3733	3.088	84	-.61
11-100 tick bites	11	7.0000	3.821	84	-.61

CHAPTER V

Summary and Conclusions

Introduction

The purpose of the study was to assess the occupational risk of Lyme disease in workers within the Assateague Island State and National Seashore Park in Berlin, Maryland, by identifying seroconversion, examining tick bite exposure and assessing preventive behavioral practices.

Discussion of Study Findings

The Assateague Island study lacked the evidence to support the belief that there is an occupational risk of Lyme disease for Assateague Island workers. Seroconversion was not identified in the study. The lack of seropositivity may be attributed to an inadequate amount of time for antibody levels to be detected, the use of antibiotics by a study participant creating a false-negative result, or that there was actually no disease in the study participants.

Although seroconversion was not identified, the study yielded some interesting findings. The researcher established that a significant relationship existed between the work site area and the number of tick bites experienced.

Data analysis revealed that employees who worked in the marsh had a greater number of tick bites. Additionally, there was a trend observed that employees who worked in the

woodland had a greater number of tick bites. These findings may have occurred for a number of reasons. However, it is thought to be directly related to the life cycle of the Ixodes dammini tick and the natural habitat which Assateague Island provides for common tick reservoirs.

During the nymphal stage, the white-footed mouse is the most common host for the Ixodes dammini tick. During the adult stage, the tick most often feeds on the white-tailed deer. Both of these animals are common to the wildlife on Assateague Island. Recognizing this factor, it is apparent that individuals who spend time in the marsh and woodland, which are natural habitat for these animals, are generally going to be at greater risk of acquiring more tick bites. Additionally, the literature suggests that deer abundance is directly related to tick abundance.
Since Assateague Island is known for its large deer population and the literature suggests that deer abundance is directly related to tick abunudance, it could be expected that individuals in these work areas would experience a greater number of tick bites.

Data analysis did not support the hypothesis that a significant relationship existed between work assignment, employment status, or preventive behaviors practiced, and the number of tick bites experienced. The lack of a significant relationship may be attributed to inconsistencies in self-reporting or the inability to

identify the Ixodes dammini tick, due to its small size.

The findings of this study differ from Bowen's et al (1984), Neubert's et al (1988), Guy's (1989) and Schwartz's (1990) studies. The acquisition of Lyme disease in Assateague Island workers was not apparent. Subsequently, the problem of subclinical cases was not validated in this study.

Limitations

The Assateague Island study had a number of limitations. As suggested in Smith's et al (1988), and Neubert's et al (1988) study's, the Ixodes dammini is so small, it often goes unnoticed and not reported as a history of a tick bite. Also, due to self-reporting there may be inconsistencies and individuals may report a crawling tick as actually being attached. Additionally, participants in the Assateague Island study may have had an inadequate amount of time between the first and second blood specimen collections to detect seroconversion, thus creating a false-negative result. Lastly, antibiotic treatment early in Lyme disease may prevent seroconversion.

Implications

The implications for this study are twofold. First, the information gained will allow nurses to target Lyme disease prevention activities towards individuals who are spending time in the marsh and woodlands. Secondly, it is hoped that as a result of this study more nurses will be encouraged to broaden their scope of practice and

participate in epidemiological research.

Although, the Assateague Island study lacked the evidence to support the hypothesis that an occupational risk of acquiring Lyme disease existed for outdoor workers, the study's findings support the hypothesis that individuals who worked on the marsh and in the woodland experienced a greater number of tick bites. Armed with this information, community health nurses are in a position to develop an educational program which is centered around reducing tick bite exposure and informing individuals about the Lyme disease process and its clinical manifestations.

The epidemiological research process requires an interdisciplinary approach in which nurses can play a key role. The concepts of epidemiology are all so familiar to the community health nurse, who performs case finding, contact tracing and health education. The epidemiological research process would expand upon the knowledge and practice which community health nurses currently employ.

Recommendations for further Study

The Assateague Island study adds to the existing knowledge base of the occupational risk of Lyme disease. Despite the lack of seroconversion, the study's findings suggest that there is an " at risk" population. Further prospective epidemiological studies are needed to pursue the occupational risk of Lyme disease in outdoor workers and address behavioral practices as well as mass

environmental control efforts.

FIRST QUESTIONNAIRE ID NO:_____ #

Appendix A

ASSATEAGUE ISLAND OCCUPATIONAL SURVEY

1. Name: _____ Date: ___/___/___

2. Age: _____ 3. Date of birth: ___/___/___ 4. Sex: ____

5. Race (Check one): White.....____
Black.....____
Hispanic.....____
Asian/Pacific Islander.....____
American Indian/Alaskan Native.____

6. Permanent Home Address: _____

City: _____ State: ____

County:_____ Zip:_____

Phone: _____

7. Present Address: _____

(If Different) City: _____ State: ____

County:_____ Zip:_____

Phone: _____

FIRST QUESTIONNAIRE ID NO:_____

ASSATEAGUE ISLAND OCCUPATIONAL SURVEY

8. Agency you work for (Check all that apply):
   National Park Service - Assateague (MD)....____
   National Park Service - Chincoteague (VA)..____
   Maryland DNR - Assateague State Park.....____
   Other, describe _____

9. Work Phone Number: (____) _____

10. Job Title: _____

11. Expected work assignment (Check best answer):
   Office Work - 100% of time.....____
   Field/Outdoor Work - 25% of time or less...____
   Field/Outdoor Work - 50% of time or less...____
   Field Outdoor Work - 75% of time or less...____
   Field/Outdoor Work - up to 100% of time....____
   DON'T KNOW.....____

12. Employment status (Check one):
   Permanent Assateague Island employee.....____
   Seasonal Assateague Island employee.....____
   Volunteer.....____
   Other, describe _____

   12A. If you are NOT a permanent Assateague Island employee:
   Date you began work on Assateague Island this season: ___/___/___

   Date you expect to finish working on Assateague Island this season: ___/___/___

13. How many years have you worked on Assateague Island? (Check one)
   Less than 1 yr ____
   1-2 yrs.....____
   3-4 yrs.....____
   5-6 yrs.....____
   7-8 yrs.....____
   More than 8 yrs ____

14. Number of hours you expect to work per week: _____

15. Employment history prior to present job (for past 5 yrs):

DATE (mo/yr) from:	to:	JOB DESCRIPTION	LOCATION OF JOB (city, co., state)	INVOLVED OUTDOOR WORK (yes or no)
____	____	_____	_____	____
____	____	_____	_____	____
____	____	_____	_____	____
____	____	_____	_____	____
____	____	_____	_____	____
____	____	_____	_____	____
____	____	_____	_____	____
____	____	_____	_____	____

16. Which of the following outdoor activities do you do in your free time? (Check all that apply or NONE)

Hunting	___	Fishing	___
Fur Trapping	___	Boating	___
Hiking	___	Farming	___
Camping	___	Gardening	___

Other outdoor activities (Specify) _____

NONE ___

17. Have you had a tick bite (attached tick) in the last 5 years?

Yes ____ No ____ Don't know ____

17A. IF YES, approximately how many times in the last 5 years?

1-10 times ____
11-30 times ____
31-100 times ____
More than 100 times ____

17B. IF NOT YES, have you lived or worked in tick infested areas in the last 5 years?

Yes ____ No ____ Don't know ____

18. Have you ever been diagnosed with the following diseases: (Check all that apply or NONE)

Rocky Mountain Spotted Fever	____	Tularemia	____
Eastern Equine Encephalitis	____	Brucellosis	____
Leptospirosis	____	Ehrlichiosis	____

NONE ____

19. Have you had any of the following symptoms in the last 5 years? (Check all that apply or NONE)

Red circular expanding rash.....____
Numbness or paralysis.....____
Arthritis, continuous or intermittent...____
Heart palpitations.....____
NONE ____

20. Have you ever been diagnosed with Lyme disease? (Check one)
Yes ____ No ____ Don't know ____

IF YES,
20a. Date diagnosed (mo/yr): ___/___

20b. What was the diagnosis based on? (Check one)

Symptoms.....____
Blood test.....____
Symptoms and blood test...____
Uncertain.....____

20c. Were you treated with antibiotics? (Check one)
Yes ____ No ____ Don't know ____

21. Have you ever had your blood tested for Lyme disease (not counting this study)? (Check one)
Yes ____ No ____ Don't know ____

21a. IF YES:

Date	Result (Check one) Positive	Negative	Don't Know
___/___/___	____	____	____
___/___/___	____	____	____
___/___/___	____	____	____

22. Do you have any additional comments which we did not ask and which you feel would be helpful to us?

_____

_____

_____

_____

THANK YOU VERY MUCH FOR YOUR PARTICIPATION!

SECOND QUESTIONNAIRE ID NO._____

Appendix B

ASSATEAGUE ISLAND OCCUPATIONAL SURVEY

1. Name: _____ Date: ___/___/___

2. Date of birth: ___/___/___

SECOND QUESTIONNAIRE ID NO._____

ASSATEAGUE ISLAND OCCUPATIONAL SURVEY

3. Job Title: _____

4. Work assignment this summer (Check best answer):

Office Work - 100% of time.....____
Field/Outdoor Work - 25% of time or less...____
Field/Outdoor Work - 50% of time or less...____
Field Outdoor Work - 75% of time or less...____
Field/Outdoor Work - up to 100% of time....____
DON'T KNOW.....____

5. Employment status (Check one):
Permanent Assateague Island employee.....____
Seasonal Assateague Island employee.....____
Volunteer.....____
Other, describe _____

6. Average number of hours you worked per week this summer:
_____

7. On the job, how many hours did you work outdoors each week this summer? (Check one for daylight hours and one for night.)

	Daylight	Night
0 hrs	____	____
1-10 hrs	____	____
11-20 hrs	____	____
21-30 hrs	____	____
31-40 hrs	____	____
over 40 hrs	____	____

8. On the job, how much time each week did you spend in each of the following areas this summer? Do not include time spent in an enclosed motor vehicle. (Check one answer for each area.)

	0 hrs	1-10 hrs	11-30hrs	over 30 hrs
Marsh	____	____	____	____
Meadow	____	____	____	____
Mowed lawn	____	____	____	____
Paved areas	____	____	____	____
Sand beach	____	____	____	____
Shrub growth	____	____	____	____
Woodland	____	____	____	____
Other (Specify):				
_____	____	____	____	____
_____	____	____	____	____

9. Not counting time at work, how much time did you spend outdoors during the average week this summer? (check one)

0 hrs	____
1-10 hrs	____
11-20 hrs	____
21-30 hrs	____
31-40 hrs	____
over 40 hrs	____

10. Not counting time at work, how much time each week did you spend in each of the following areas this summer? Do not include time spent in an enclosed motor vehicle. (Check one answer for each area.)

	0 hrs	1-10 hrs	11-30hrs	over 30 hrs
Marsh	____	____	____	____
Meadow	____	____	____	____
Mowed lawn	____	____	____	____
Paved areas	____	____	____	____
Sand beach	____	____	____	____
Shrub growth	____	____	____	____
Woodland	____	____	____	____
Other (Specify):				
_____	____	____	____	____
_____	____	____	____	____

11. Did you have any tick bites (attached ticks) this summer?

Yes____ No____ Don't Know____

11A. IF YES, approximately how many tick bites this summer?

1-10 tick bites	____
11-30 tick bites	____
31-100 tick bites	____
More than 100	____

12. What preventive measures did you take to reduce exposure to ticks and other pests this summer? (Check all that apply for job and leisure time)

	On Job	Leisure time
Wore light colored clothes	_____	_____
Wore long pants	_____	_____
Tucked pant legs into socks	_____	_____
Wore long-sleeved shirts	_____	_____
Wore hats	_____	_____
Used insect repellant on skin	_____	_____
Used insect repellant on clothing	_____	_____
Used permanone on clothing	_____	_____
Checked yourself for ticks	_____	_____

13. Have you had any of the following symptons this summer? (Check all that apply or NONE)

Red circular expanding skin rash _____
Numbness or paralysis of face, arms or legs _____
Arthritis (severe pain, redness, and/or swelling in a joint) _____
Heart palpitaions (irregular or skipped heart beats) _____
NONE _____

13A. Were you treated by a physician for these symptoms this summer?

Yes _____ No _____

14. Did you have any blood drawn this summer (except as part of this study) for any of the following diseases? (Check all that apply or NONE)

Rocky Mountain Spotted Fever _____
Eastern Equine Encephalitis _____
Leptospirosis _____
Lyme disease _____
NONE _____
Tularemia _____
Brucellosis _____
Ehrlichiosis _____

15. If you consulted a physician or had blood drawn outside of this study, may we contact the physician or health care provider involved to obtain information regarding Lyme disease?

Yes ____ No____

IF YES, a medical records release form will be given to you to complete and sign.

16. Do you have any additional comments which we did not ask and which you feel would be helpful to us?

_____

_____

_____

_____

THANK YOU VERY MUCH FOR YOUR PARTICIPATION!

Appendix C

Statement of Approval

Committee on Human Volunteers

Salisbury State College

Date March 18, 1991

MEMORANDUM TO: Dr. Douglas Moore/Colleen K. Parrott

FROM : Chairman, Committee on Human Volunteers

SUBJECT : Human Volunteers study for thesis

Assateague Island Occupational Study
Title of Study

Salisbury State University
Grant Application No. Sponsoring Agency

Dr. Douglas Moore
Principal Investigator or Program Director

The Committee on Human Volunteers has considered the above application and, on the basis of available evidence, records its opinion as follows:

(1) The rights and welfare of individual volunteers are adequately protected.

(2) The methods to secure informed consent are fully appropriate and adequately safeguard the rights of the subjects (in the case of minors, consent is obtained from parents or guardians).

(3) The investigators are responsible individuals, competent to handle any risks which may be involved, and the potential medical benefits of the investigation fully justify these studies.

(4) The investigators assume the responsibility of notifying the Committee on Human Volunteers if any changes should develop in the methodology or the protocol of the research project involving a risk to the individual volunteers.

Chairman Dr. Francis I. Kane

3/86

cc: Colleen Parrott, Dr. Karin Johnson

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Education

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Positions Held

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1977-1982 Staff Nurse
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Honors

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Publications

Thesis - Lyme Disease: A Prospective Study of
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