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DISSERTATION

**A NATIONAL SURVEY OF RISK PERCEPTIONS AND
PRACTICES TO PREVENT
TICK-BORNE LYME DISEASE AND MOSQUITO-BORNE
VIRAL ENCEPHALITIS**

**Submitted by
James Edward Herrington, Jr.
Department of Environmental Health**

**In partial fulfillment of the requirements
For the Degree of Doctor of Philosophy
Colorado State University
Fort Collins, Colorado
Summer 2002**

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WE HEREBY RECOMMEND THAT THE DISSERTATION PREPARED UNDER
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A NATIONAL SURVEY OF RISK PERCEPTIONS AND PRACTICES
TO PREVENT TICK-BORNE LYME DISEASE AND MOSQUITO-BORNE
VIRAL ENCEPHALITIS BE ACCEPTED AS FULFILLING IN PART
REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

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ABSTRACT OF DISSERTATION
A NATIONAL SURVEY OF RISK PERCEPTIONS AND
PRACTICES TO PREVENT
TICK-BORNE LYME DISEASE AND MOSQUITO-BORNE
VIRAL ENCEPHALITIS

Behavioral epidemiology has become an increasingly important science of inquiry for the examination of health-related behaviors in populations, the association of these behaviors with well-being, morbidity, and mortality, and the discovery of techniques for predicting, improving, and sustaining healthy behaviors. Thematic areas common to health behavior theories were used to design this study and examine the results observed.

A 55-item survey instrument was successfully administered to 1489 adults in the U.S. and an over-sample of 261 adults in six states in the Northeast (CT, DE, NJ, NY, PA, RI) regarding ticks and tick-borne Lyme disease and mosquitoes and mosquito-borne viral encephalitis. Index measures for tick and mosquito bite prevention were created. Among U.S. adults, perceived harm to self about being bitten by ticks appeared to be the most robust predictor of behavioral action to prevent tick bites (OR = 8.3; 95% CI = 6.3, 11.1). Respondents from the

Northeastern states over-sample who knew someone with Lyme disease were significantly more likely (OR = 22.1; 95% CI = 3.6, 136.5) to take action to prevent tick bites. Moreover, respondents from the Northeastern sample, but not the U.S. sample, who stated they recently took action to prevent tick bites were 2.9 times more likely to choose tweezers (vs. the erroneous choice of a hot match) to remove an embedded tick when compared with respondents who stated they did not recently take action to prevent tick bites. Pet ownership (OR = 2.1; 95% CI = 1.3, 3.6) was also a statistically significant predictor of the adoption of precautions by U.S. adults to prevent tick bites.

Regarding mosquitoes, analyses revealed that being concerned about being bitten by mosquitoes, believing that staying indoors in late afternoon and evening was protective, that mosquito repellent is not harmful to health, owning dogs and/or cats as pets, being married, and being between 18-44 years of age were statistically significant predictors of the mosquito bite prevention index. Among U.S. adults perceived harm to self about being bitten by mosquitoes appeared to be the most robust predictor of behavioral action to prevent mosquito bites (OR = 7.3; 95% CI = 4.3, 12.2).

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DEDICATION

In remembrance of my late wife, Carolyn J. McCrossin, for her loving support and ceaseless encouragement to “Say what you think, not simply what others want to hear.”

With thanks to my parents for encouraging me to pursue academic challenges, explore the world, and remember family and home. And for my children, Christopher, Chelsea, and Benjamin, the most precious of gifts I could possibly know.

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CHAPTER 1

Introduction

Behavioral epidemiology has emerged in the last two decades as an important science of inquiry and practice in public health, due in large part to human immunodeficiency virus (HIV), an infectious disease that has resulted in over 18 million deaths worldwide since the epidemic was first identified (Centers for Disease Control and Prevention 1981; Centers for Disease Control and Prevention 1982a; Centers for Disease Control and Prevention 1982b) and for which behavioral change is the primary determinant of prevention (World Health Organization 2000). The term “behavioral epidemiology” has been used in the literature since the late 1970s (Kaplan RM 1985; Owen N 1989; Raymond JS 1989; Kaplan RM and Criqui MH 1985; Sexton MM 1979) and has recently been further conceptualized (Sallis JF, Owen N, and Fotheringham MJ 2000).

In a general context, behavioral epidemiology can be defined as the descriptive and analytical study of disease distribution and etiology in terms of human actions that may relate to exposure risk and subsequent illness. This requires an intellectual and practical understanding of the precursors, motivators, and barriers to the adoption of healthy behaviors and the methods for changing unhealthy behaviors, particularly when

only changes in individual behavior will prevent infection, such as with HIV (Centers for Disease Control and Prevention 1995b; Valdiserri RO, Holtgrave DR, and Brackbill RM 1993). While human behavior has been generally recognized as a factor to consider in infectious disease transmission, control, and prevention, such as in John Snow's classic study of cholera in mid-19th century London (Snow J 1936), where removal of the pump handle on a contaminated water well prevented the human action that exposed individuals to the causative agent Vibrio cholerae, the advent of HIV in the early 1980s forced human behavior into the forefront of epidemiological inquiry.

Concern about human behavior affecting the environment was thrust into the public conscientiousness in the mid-1960's by Rachel Carson's assessment in her book Silent Spring (Carson R 1962) of man-made DDT's impact on wildlife and accumulation in the food chain, ultimately affecting man, the highest level predator. In the 1970's the imperative, as expressed by the World Health Organization (WHO) (World Health Organization 1977) was that personal health was a basic human right. By contrast, public health and preventive medicine were being expropriated by the corporate medical establishment, according to Ivan Illich in Medical Nemesis (Illich I 1975). Recognition of the importance of academic inquiry to delineate and systematically define the panoply of parameters that influence human behavior at the level of the individual, family, and community, and how these factors may be employed as points of intervention in public health, has been well described within the disciplines of health education (Israel BA et al. 1993; Steuart GW 1967; Steuart GW 1975;

Steuart GW 1993b; Steuart GW 1993a) and chronic disease epidemiology (Kaplan BH, Cassel JC, and Gore S 1977; Henry JP and Cassel JC 1969; Cassel JC 1964). By the 1980s, scientific research was beginning to demonstrate that personal health behaviors (Green LW and Kreuter MW 1991) played a major role in premature morbidity and mortality related to chronic disease and injuries (Remington PL et al. 1988). In 1984, the U.S. Centers for Disease Control, in collaboration with 15 states, developed the Behavioral Risk Factor Surveillance System (BRFSS) prevalence surveys, the first national effort to quantify the major behavioral risks associated with premature morbidity and mortality among adults (Buehler JW 1998). The BRFSS was to promote data collection and monitoring at the state-level on behaviors, in addition to attitudes and knowledge, that would be especially useful for planning, initiating, supporting, and evaluating health promotion and disease prevention programs addressing chronic illness and injuries (Remington PL et al. 1988; Robertson LS 1992; Jackson C, Jatulis DE, and Fortmann SP 1992; Nebot M et al. 1994). Within ten years all states, the District of Columbia, and three U.S. territories participated in the BRFSS from which summary data were published annually (Centers for Disease Control and Prevention 2001b; Centers for Disease Control and Prevention 1998c; Centers for Disease Control and Prevention 1999e; Centers for Disease Control and Prevention 1998a; Centers for Disease Control and Prevention 1998b; Centers for Disease Control and Prevention 1999a; Centers for Disease Control and Prevention 1997e).

More recently, the BRFSS was used to address risk factors related to Lyme disease, an arthropod-borne bacterial infection first identified in the U.S. in the late 1970s (Herrington JE et al. 1997; Herrington JE 1995). The purpose of a pilot study by Herrington et al. (1997) was to differentiate Lyme disease-related knowledge, attitudes, and behavioral risk factors among representative samples of persons residing in Connecticut, a state with a high incidence of Lyme disease, Maine, a state with intermediate incidence, and Montana, a state where the etiologic agent was not known to occur. The pilot study found statistically significant associations between adopting precautions to prevent Lyme disease (e.g., having taken specific steps in the past year to prevent oneself from getting Lyme disease), and the perceived risk of getting Lyme disease, moderate to high knowledge about Lyme disease, and knowing anyone who had Lyme disease. These associations were significant in Connecticut and Maine, but not in Montana, as would be expected, given the epidemiology of Lyme disease in the U.S.

The control of infectious diseases transmitted by mosquitoes, ticks, or fleas has relied on key partnerships between epidemiologists, disease surveillance personnel, and vector ecologists (Gubler DJ 1998; Gubler DJ 1996; Gubler DJ 1997b). Control techniques have traditionally employed insecticides or acaricides, (Schulze TL, Jordan RA, and Hung RW 1995; Schulze TL et al. 1994; Curran KL, Fish D, and Piesman J 1993). The need for systematic research into the behavioral component of vector-borne infectious disease control has been promoted since the late 1970s (Dunn FL

1983; Dunn FL 1979; Gillett JD 1985; Dunn FL 1989). Ethnographic, psychosocial, participant observation, sociomedical, and similar qualitative studies have attempted to understand knowledge, beliefs, and practices related to Chagas' disease (Bryan RT et al. 1994), dengue fever (Lloyd LS et al. 1994; Gubler DJ 1989; Gubler DJ and Clark GG 1994; Winch P et al. 1991), guinea worm (Brieger WR and Kendall C 1992), malaria (Sexton JD 1994), onchocerciasis (river blindness) (Brieger WR et al. 2002), and trachoma (Dunn FL 1985), among other vector-borne infectious diseases.

Personal protection methods for minimizing exposure to infected vectors is increasingly being encouraged (Centers for Disease Control and Prevention 2000a). Yet, little theory-based research had been published that systematically describes and analyzes the behavioral factors, and associated social and cultural factors, that influence the adoption (or rejection) of personal protective behaviors (Dunn FL 1990).

Further, few theory-based empirical studies are published that address the adoption of personal protection measures to prevent vector-borne infectious diseases and the effectiveness of those measures in disease reduction (Herrington JE 1995; Hallman W et al. 1995; Hayes EB et al. 1999; Herrington JE 2002). Moreover, the literature is sparse regarding public perceptions among adults in the United States of risks posed by mosquitoes, ticks, and fleas and the diseases they carry (Sarti E et al. 1997; Marketing and Research Resources, Inc 1997; Schwartz BS and Goldstein MD 1990; Shadick NA et al. 1997). With roots in the psychological sciences and public health's central discipline, epidemiology, theory-based behavioral epidemiology

examines the distribution of health-related behaviors in populations, the association of these behaviors with well-being, morbidity, and mortality, and attempts to discover techniques for changing, improving, predicting, and sustaining healthy behaviors (Conners M and Norman P 1996; Elder JP 2000). Thus, theory-based behavioral epidemiology is well-placed to examine the distribution of health-related behaviors regarding the prevention of vector-borne infectious diseases, the association of health-related behaviors with vector-borne disease incidence, and the identification of techniques for changing, improving, and sustaining precautions to prevent infections transmitted by arthropods.

Purpose

As vector-borne infectious diseases emerge and re-emerge, better understanding of public knowledge, attitudes, and practices, as well as risk perceptions regarding personal susceptibility and disease severity, may provide important information from which effective prevention programs can be designed. As has been demonstrated with HIV prevention and the BRFSS, public health prevention programs should be designed with a more thorough understanding of the psychological, behavioral, educational, sociodemographic, and other salient factors that may motivate individuals to adopt precautions against a health hazard. Therefore, this study was designed to establish a nationally representative baseline on knowledge, attitudes, and practices regarding two vector-borne infectious diseases, Lyme disease and arboviral

encephalitis. Specifically, this study identifies and examines potential factors that could influence and motivate individuals to adopt measures to prevent personal infection from agents transmitted by ticks and mosquitoes, specifically the spirochete Borrelia burgdorferi that causes Lyme disease and the several viruses that cause arboviral encephalitis (i.e., Eastern equine, LaCrosse, St. Louis, West Nile, and Western equine encephalitis viruses). There were four objectives for this study. First, the thematic areas common to theories of health behavior were used to develop a series of questions that would elicit levels of knowledge about a given hazard, the perceived severity of the hazard, the perceived susceptibility to the hazard for oneself and for others, and the perceived effectiveness of recommended measures to prevent exposure to the hazard (Janz NK and Becker MH 1984; Becker MH 1974; Bandura A 1977; Ajzen I and Fishbein M 1980; Connors M and Norman P 1996; Weinstein ND 1988; Weinstein ND 1993; Bandura A 1995; Green LW and Kreuter MW 1991). The questions selected would be based on focus-group research and pretesting. Thus, for the present study, data were collected on the following: levels of knowledge and experience regarding ticks, Lyme disease, mosquitoes, and arboviral encephalitis; the perceived severity of Lyme disease and arboviral encephalitis; the perceived susceptibility of being bitten by ticks or getting Lyme disease and being bitten by mosquitoes or getting arboviral encephalitis; the specific practices used to prevent tick and mosquito bites and the frequency of these practices; the beliefs about the effectiveness of the specific behaviors to prevent tick and mosquito bites; the sources of information about Lyme

disease and arboviral encephalitis; the other prevention practices used by respondents to prevent tick and mosquito bites (open-ended responses); the knowledge of whether the repellent used contained the chemical DEET; the beliefs about the likelihood of oneself or one's children getting sick from using insect repellent; the preference for using a recommended method to remove an embedded tick (tweezers) or a folk-method (hot match head); and the willingness to purchase a vaccine against Lyme disease. Further, several sociodemographic variables were also identified that might influence the adoption of precautions to prevent tick and mosquito bites, including newspaper readership and frequency, sources of news information, cat and dog ownership, international travel, education level, age, Hispanic origin, employment status, race, marital status, household size, residence type, urbanicity of residence, length of residence occupancy, health insurance status of respondent and respondent's household, household income, number of telephone numbers in the residence, and gender (Appendix C, Table 2).

The second objective of this study was to obtain a data set that would be representative of and generalizable to the U.S. adult population. As detailed in Chapter 3: Methods and Materials, this objective was achieved under contract with the Survey Research Center, University of Maryland, College Park, through funding provided by the National Science Foundation and the Centers for Disease Control and Prevention.

A third objective of this study was to, not only detail the frequency and distribution of knowledge levels, attitudes, and practices regarding ticks and Lyme

disease, and mosquitoes and arboviral encephalitis, but also to describe those factors that could be predictive of behaviors to prevent tick and mosquito bites. This was accomplished through the use of univariate and multivariate statistical analyses as described in Chapter 3.

Finally, a fourth objective of this study was to prepare two publishable manuscripts for submission to peer-reviewed public health and preventive medicine journals that describe the findings of the present study. Chapter 4 presents the tick and Lyme disease portion of this study while Chapter 5 offers findings from the mosquito and arboviral encephalitis part of the study.

CHAPTER 2

Literature Review

Risk Perceptions and Human Motivation

In the human experience, a health risk can be defined in terms of an event that threatens the well-being of an individual. Life threatening examples might include a house fire, electrocution, or drowning. A reasonable person will perceive these events as risks to life and would not knowingly go into a house fire, contact high amperage electric wires, or venture into deep water unable to swim or without a flotation device. In other words, a reasonable person would adopt precautions to minimize risks to personal health and safety. How a person perceives a certain activity or exposure as risky is based on a threat to well-being. The threat may be immediate, impending, or delayed. The severity of threat may range from harmless to fatal. Self-preservation suggests that subtle and complex threats will materialize only to the extent that the most direct and obvious threats are dealt with first (Ehrlich PR 2000). This motivation for self-preservation was illustrated over 50 years ago by Abraham Maslow in his Hierarchy of Needs Theory which states that an individual's behavior is stimulated by unmet needs, and that certain basic physiological and safety needs will be attended to first and foremost (Figure 1) (Maslow AH 1970; Maslow AH 1969; Maslow AH

1968; Maslow AH 1943).

Initially five and later expanded to eight levels, and often represented as a pyramid or ladder, the Hierarchy of Needs Theory posited by Maslow arranged these needs based on the order of importance of each. Fundamentally, a person's most basic needs are met first, primarily the physiological requirements of hunger, thirst, sleep, sex, and bodily comforts. The physiological needs are the strongest because if a person

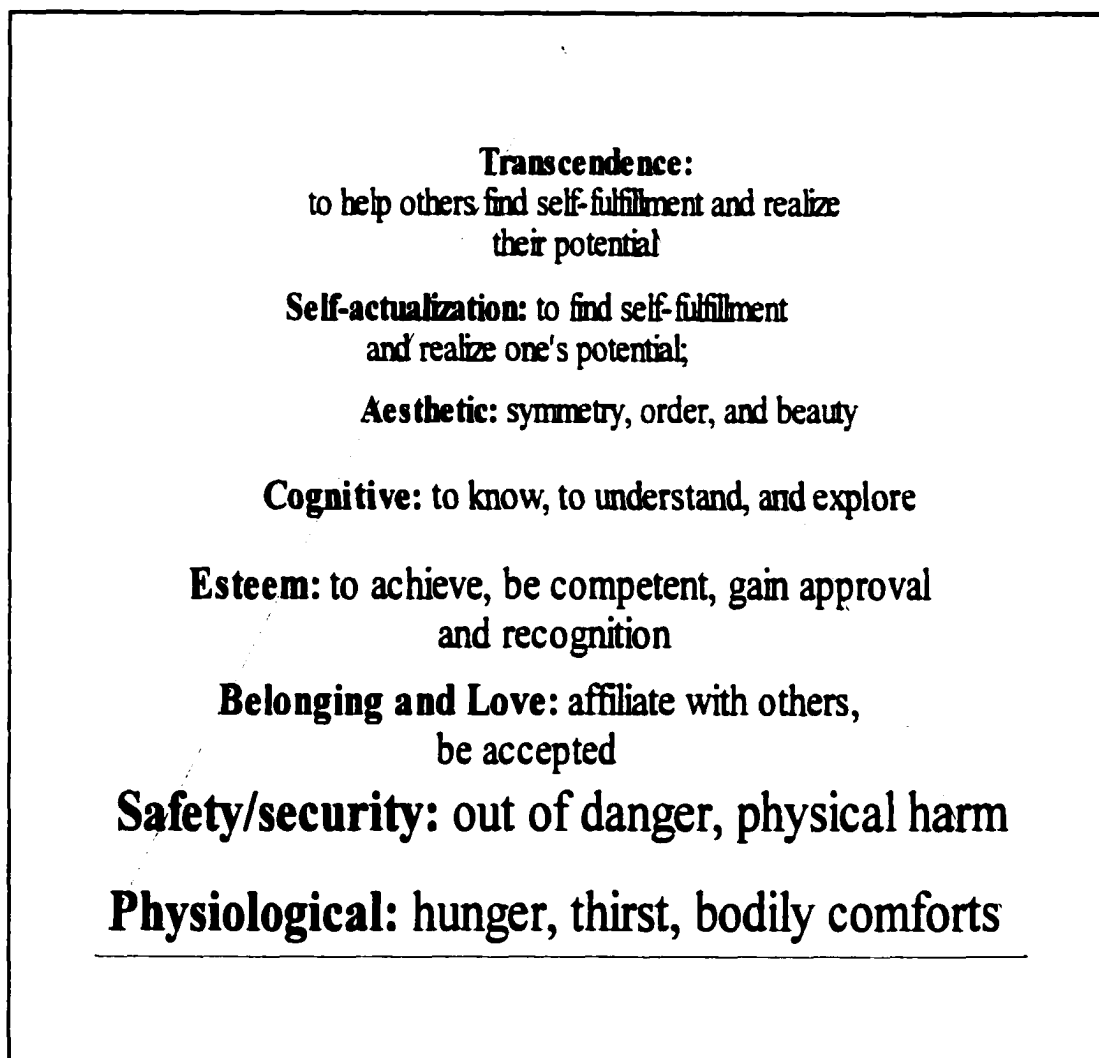


Figure 1. The eight levels in Maslow's Hierarchy of Needs Theory regarding human motivation (Maslow AH, 1943).

were deprived of all needs, the physiological ones would come first in motivating a person's search for satisfaction. When the basic physiological needs are satisfied they are replaced by safety needs, reflecting a person's motivation for self-preservation against danger or threat. In turn, self-preservation and security needs are replaced by the need for love and belonging, needs that satisfy a person's desire to belong to a group, to give and receive friendship, and to associate with others. When these needs have been satisfied, Maslow suggested that there will be needs of esteem, i.e. a person's desire for self-appreciation, respect, recognition and appreciation followed by cognitive and aesthetic needs, i.e., a person's need to know, understand, and explore his/her environment and to find symmetry, order, and beauty in that environment, respectively. Finally, Maslow believed that a person had a need for "self-actualization" in that:

"Even if all these needs are satisfied, we may still often (if not always) expect that a new discontent and restlessness will soon develop, unless the individual is doing what he is fitted for. A musician must make music, an artist must paint, a poet must write, if he is to be ultimately happy. What a man can be, he must be. This need we may call self-actualization (Maslow, 1943, page 383)."

Beyond self-actualization Maslow believed some persons would be motivated to a level he called "transcendence" wherein the person would strive to help others find self-fulfilment and realization of their potential, in the manner of Zen monks (Maslow AH 1969).

In the context of the current study, Maslow's second hierarchy level of safety

and security, where perceptions of risk guide a person's motivation to adopt precautions for self-preservation and safety, is the theoretical underpinning for the following discussion on risk perception and health protective behavior.

In addition to immediacy, the perceived severity and susceptibility of a risk to one's health determine the behavior used to avoid a threat (Slovic P 1987; Wildavsky A and Drake K 1990). When a health risk is obviously immediate, potentially severe, and the person attending to the risk is personally susceptible, the probability increases that the person will take action by adopting precautions to avoid the risk (Slovic P 1987; Fischhoff B, Watson SR, and Hope C 1984). Thus, an individual's perception of a risk will be influenced by an assessment of the probability of the risk event occurring and the level of damage the risk event will cause (Jungermann H and Slovic P 1993). The prominence of concern about an event is a function of a similar event having recently occurred. For example, in the days following an airline disaster, an individual may judge personal risk of being a victim in an airline accident to be greater than during time periods when no airline disasters have occurred, even though the statistical probability of a similar event occurring will not necessarily have increased. In other words, the temporal and spatial prominence of the risk event will influence the individual's perception of its riskiness, regardless of the rational and statistical probability of the event occurring (Slovic P 1987; Slovic P 1993; Fischhoff B 1995).

The context in which the risk event is framed will affect perceptions of its damage potential (Jungermann H and Slovic P 1993). To illustrate, assume that a new

program to control a deadly infectious disease has been shown through sound scientific study to be less than 100% effective in preventing a lethal outcome. Further, assume that it is known scientifically that some loss of life will absolutely occur. The new control program can be framed either in terms of number of lives that will be lost or the number of lives that will be saved. Adults evaluate gains differently from losses and, generally, prefer the certainty of a gain to the certainty of a loss (Jungermann H and Slovic P 1993). This is termed an optimistic bias (Weinstein ND 1989). In the self : other risk dyad, comparison will almost always favor the self. In other words, when asked about personal risk, an individual will consistently underestimate the risk to self when compared with the risk to others. Optimistic biases are common for both positive and negative events, while pessimistic biases are generally rare (Weinstein ND and Klein WM 1995; O'Riordan T 1995). Risk is also a cultural phenomenon for which there is no independently validated definition of risk when separated from its social context. Thus, the perception of what constitutes a risky behavior or event can be heavily influenced by the cultural environment of the perceiver (Wildavsky A and Drake K 1990; Holdren J 1983).

For example, by Western standards, an extreme, but not uncommon, example of how risk is influenced by culture would be the current practice of “pharonic circumcision” or female genital mutilation (FGM) (Lightfoot-Klein H 1989a). In this cultural rite of passage commonly practiced throughout the Sahelian countries from Senegal to Sudan, adolescent girls are subjected to clitorrectomy and infibulation

(suturing closed the labia majora) (Lightfoot-Klein H 1989a; Lightfoot-Klein H 1989b). These procedures are performed ostensibly to keep a young woman from becoming promiscuous before and after marriage. It has been well documented that FMG can result in septicemia arising from infections acquired from unsterile cutting tools (Lightfoot-Klein H 1989a). Maternal death during childbirth can also result due to an underdeveloped birth canal. (Lightfoot-Klein H 1989a). Thousands of young girls are circumcised each year in certain African countries (Lightfoot-Klein H 1989a). In their culture, the practitioners of FMG apparently perceive the threat of promiscuity outweighs the medical and psychological risks inherent in this practice (Lightfoot-Klein H 1989a; Lightfoot-Klein H 1989b).

In the U.S. and Canada, male circumcision has been common in the last century owing to cultural acceptance of the practice and the apparent lack of negative medical or psychological effects (Denniston GC 1996b; Denniston GC 1996a; Tiemstra JD 1999). However, changing Western cultural values and greater scientific inquiry regarding the practice of male circumcision indicate a growing number of medical associations now recommend against neonatal male circumcision (Denniston GC 1996b; Denniston GC 1996a; American Academy of Pediatrics 1999; American Medical Association 1999; Tiemstra JD 1999). As cultural values shift and influence what individuals know or perceive to be “risky,” female and male circumcision may well become as anachronistic as the medical practices of purging and bloodletting (Morris K 1998; Colman E 1999; Cooper C 1999).

Within the United States, extreme diversity in perceptions of what is risky has been demonstrated (Slovic P 1987; Slovic P 1993; Slovic P, Kraus N, and Covello VT 1990). For example, risk perception research has examined how people characterize and evaluate hazardous activities and technologies in the United States (Roth E et al. 1990; Holtgrave DR and Weber EU 1993). Taxonomic classification schemes have been used to quantify judgements about the riskiness of diverse events, technologies, and activities (Johnson BB and Slovic P 1995; Fishbein DB, Dawson JE, and Robinson LE 1994). For example, a comparative ranking of various activities and technologies was done by different homogeneous groups of individuals that revealed patterns of acceptable risk-benefit trade-offs. When ranking 30 risky activities and technologies^a, nuclear power was rated the number one risk to human life by three lay groups: the League of Women Voters, college students, and service club^b members (Slovic P 1987). By contrast, a group of nuclear power experts ranked in 20th position nuclear power as a risk to human health. However, this same group ranked diagnostic x-rays 7th in riskiness, whereas the three lay groups ranked the riskiness of diagnostic x-rays in 22nd, 17th, and 24th positions, respectively.

^aAlcoholic beverages, bicycles, commercial aviation, contraceptives, diagnostic x-rays, electric (non-nuclear) power, electronic games, fire fighting, food coloring, food preservatives, general (private) aviation, handguns, high school and college football, home appliances, hunting, large construction, motorcycles, mountain climbing, nuclear power, pesticides, police work, power mowers, prescription antibiotics, railroads, skiing, smoking, spray cans, surgery, swimming, and vaccinations.

^bFor example, persons who belonged to Rotarians, Lion's Club, Optimists, Junior League, or similar service clubs.

Immunizations were considered to pose the least risk to human health and were ranked as low risk by all four groups at 30th, 29th, 29th and 25th positions, respectively (Slovic P 1987). The differences in risk perceptions by these groups of individuals serves to illustrate that the concept of risk means different things to different people. Each of these preceding four groups of persons had different experience, knowledge, and cultural associations with the hazards they ranked. Those hazards with which the perceiver had limited experience, such as nuclear waste, or were considered uncontrollable, such as nuclear reactor accidents, or had catastrophic and fatal consequences were ranked high on the perceiver's severity scale. However, personal susceptibility for these same hazards may be perceived as low if the perceiver does not believe that the risk will directly affect oneself or one's family (Slovic P 1987; Slovic P, Kraus N, and Covello VT 1990). In a study that considered theories of risk perception the authors concluded that:

“[H]owever conceptualized -- whether as political ideology or cultural bias[es] -- worldviews best account for patterns of risk perception. In summary, the great struggle over perceived dangers of technology in our time are essentially about trust and distrust of societal institutions, that is, about cultural conflict (Wildavsky A and Drake K 1990)(page 56).”

Thus, immediacy, severity, susceptibility, and knowledge of what behaviors are protective inform motivation to protect oneself. The temporal, spatial, and cultural context of the risk (Slovic P 1993; Slovic P, Kraus N, and Covello VT 1990) are factors that may also determine whether an individual adopts protective precautions and

serve as predictors of the intention to adopt practices against real (Weinstein ND 1989; Slovic P, Kraus N, and Covello VT 1990) or imagined (Foster KR, Bernstein DE, and Huber PW 1993) health risks.

Health-Protective Behavior

The course of action an individual takes to prevent or moderate exposure to a hazardous agent or event that is perceived to be a threat to well-being can be termed health-protective behavior (Weinstein ND 1993). Several theories and models of health-protective behavior have been proposed, including the health belief model (Janz NK and Becker MH 1984; Becker MH 1974), the social learning theory (Bandura A 1977; Bandura A 1995), the theory of reasoned action (Ajzen I and Fishbein M 1980; Ajzen I and Madden JT 1986), the protection motivation theory (Rogers RW 1983), and the precaution adoption process (Weinstein ND and Nicolich M (1992, unpublished manuscript); Weinstein ND 1988; Weinstein ND 1993; Weinstein ND, Rothman A, and Sutton S 1998; Weinstein ND and Sandman PM (in press)).

According to Weinstein (1993), there is no consensus that one of the above theories and models is more accurate or that any model prescribes variables that are more influential, predictive, or descriptive when attempting to understand health-protective behaviors. All focus on beliefs about health risks and behaviors that are considered health-protective (Weinstein ND 1993). The health belief model, the social learning theory, and the theory of reasoned action are widely cited and have been employed by researchers when attempting to understand, explain, and predict health-

related behaviors (Weinstein ND 1993). The models are similar in that each is based on the assumption that a perceived negative health outcome and the desire to avoid or reduce its severity generates motivation for self-protection, and, hence, behavior change (Weinstein ND 1993). The health belief model and the theory of reasoned action in particular are models that rely on perceived severity of a health consequence as the motivation for action (Janz NK and Becker MH 1984; Becker MH 1974; Ajzen I and Fishbein M 1980; Ajzen I and Madden JT 1986). The social learning theory relies more on the concept of self-efficacy as a determinant of behavior (Bandura A 1977; Bandura A 1995). The concept of self-efficacy is also central to the operational definition of health promotion: “[T]he process of enabling people to increase control over, and to improve, their health (underline added) (Anonymous 1986).” However, these models have been criticized for not adequately addressing the apparent mercurial, irrational, and spuriousness of human decision-making and behavior regarding health risks (Weinstein ND 1993; Sutton SR 1987; Weinstein ND, Rothman A, and Sutton S 1998). The following two theories, the Revised Protection Motivation Theory (Rogers RW 1983) and the Precaution Adoption Process Model (Weinstein ND 1988; Weinstein ND and Sandman PM (in press)), are discussed in detail below given they attempt to more thoroughly refine the thought processes that people may undertake when assessing a health risk and deciding what to do to prevent or negate it.

Rogers’ Revised Protection Motivation Theory (RPMT) suggests (Rogers RW 1983) that an individual, when confronted with a risk event, will assess two things: (1)

the threat posed by the event (i.e., threat appraisal), and (2) the ability to cope with the threat (i.e., coping appraisal). Threat appraisal is a process by which the individual considers intrinsic rewards, such as a positive mental attitude, good physical health, and extrinsic rewards, such as social approval for not being sick or unhealthy, that may be associated with the activity, such as doing a bodily check for ticks infected with the bacterium that causes Lyme disease. These rewards are weighed against the perceived severity of the threat, like a debilitating arthritis, and an individual's perceived vulnerability or exposure to the threat, such as from hiking in grassy areas where infected ticks are present. If severity and vulnerability outweigh intrinsic and extrinsic rewards, a maladaptive response may result. That is, the individual will not act to protect him or herself. Fear arousal messages may influence the individual's response to the threat event, though not directly. According to RPMT, cognitive mediating processes outweigh emotive processes, such as fear arousal, in affecting protection motivation (Rogers RW 1983).

Coping appraisal is the evaluation process used by an individual to govern the threat and negate its danger and is influenced by three factors: (1) response efficacy or the belief that the recommended response is effective, such as "Using an insect repellent on my skin will prevent mosquito and tick bites," (2) self-efficacy or the belief that one can successfully accomplish the response, such as "I can check for ticks after each outing in grassy areas," and (3) the cost of performing the recommended behavior in terms of inconvenience, monetary, unpleasantness, difficulty, complexity, side-effects,

and/or disruption of daily routines, for example, “I do not have time to do tick-checks; I cannot afford insect repellent or am fearful of its toxic effects; My children cannot successfully perform tick-checks themselves.” If the individual believes that the recommended coping response is effective and that he or she can carry out the recommended response, then the individual will act, depending on the threat appraisal process previously described (Rogers RW 1983).

Roger’s Revised Protection Motivation Theory further states that environmental and intrapersonal sources of information about an event will influence whether a person initiates the threat and coping appraisal processes. Environmental sources include verbal persuasion, such as what other people say, and observational learning, such as seeing what happens to others. Intrapersonal sources include such things as personality factors and prior experience with similar events. The information from these two sources initiate the cognitive mediating process whereby the individual appraises the threat and his or her ability to cope with the threat (Rogers RW 1983).

The rational ideal implicit in RPMT assumes that, if the balance appears favorable, an individual will weigh expected benefits against costs when considering a health precaution and adopt the precaution (Rogers RW 1983). The principal variables in RPMT are an individual’s perceived susceptibility to a threat, the perceived severity of the threat, the perceived effectiveness of the precaution, and the perceived costs of adopting the precaution (Rogers RW 1983).

The main limitation of the above model, as suggested by Weinstein et al., is a

uniform assumption that an individual's likelihood of preventive action is a function of an individual's beliefs and that these beliefs are held constant during the adoption process (Weinstein ND and Nicolich M (1992, unpublished manuscript); Weinstein ND 1993). Moreover, those factors included in the model are presumed to remain constant from the point at which an individual learns of a threat to initiation of change (Weinstein ND and Nicolich M (1992, unpublished manuscript); Weinstein ND, Rothman A, and Sutton S 1998).

Weinstein's Precaution Adoption Process Model (PAPM) considers health protective behavior from a stage theory perspective (Weinstein ND, Rothman A, and Sutton S 1998). PAPM suggests the adoption of precautions is a dynamic process that, over time, leads to changes in beliefs and intentions that, ultimately, lead to action. In contrast to linear models, PAPM suggests that human decision-making and behavior are complex processes not adequately described by quantitative changes in the values of perceived costs and perceived benefits as measured along a continuous dimension from ignorance to action (Weinstein ND and Sandman PM (in press)). As a stage theory, PAPM suggests that a person will occupy a given stage in the process of adopting a preventive behavior at a given moment and then moves forward from that stage to the next stage (or regresses backward to the previous stage) based on factors that influence the person's decision making process and behavior, as described below (Weinstein ND, Rothman A, and Sutton S 1998) (Weinstein ND 1988; Weinstein ND 1993; Weinstein ND, Rothman A, and Sutton S 1998; Weinstein ND and Sandman

PM (in press))

The PAPM posits a series of five distinct stages through which an individual moves from learning about a hazard to actual adoption of preventive measures (Figure 2). An advantage of a stage theory approach to precaution adoption is that individuals are assumed to behave in qualitatively different ways depending on the position or staging point in the precaution adoption process. Also, information and interventions will differ in type, content, and magnitude from one stage to the next, while recognizing that the behavior may not be retained due to the dynamic nature of the precaution adoption process (Weinstein ND, Rothman A, and Sutton S 1998).

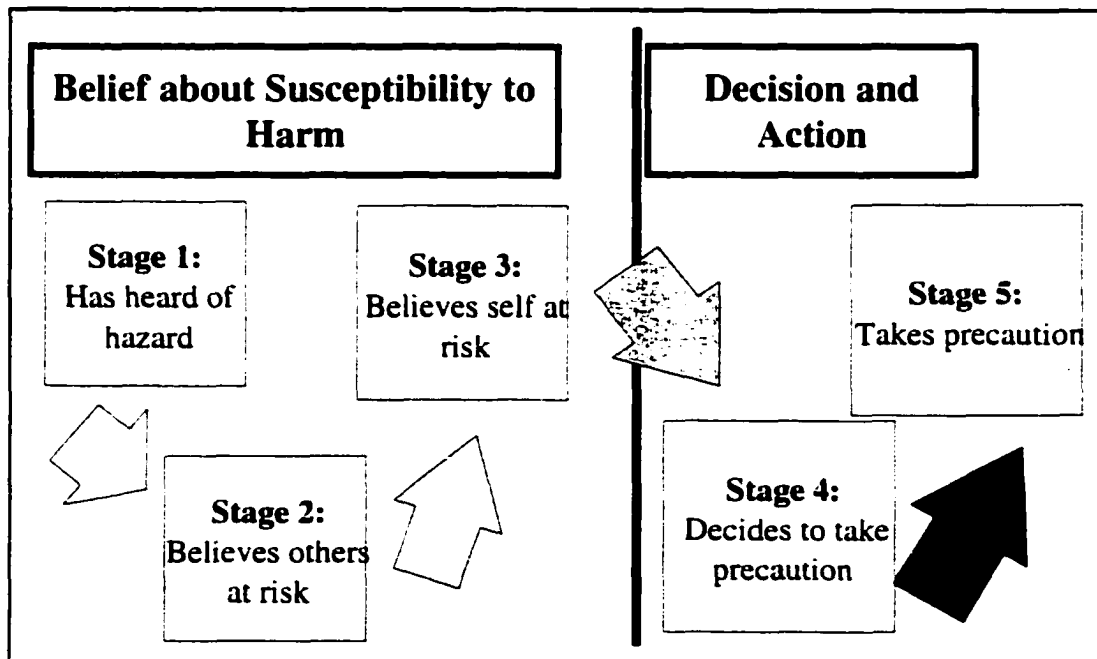


Figure 2. The precaution adoption process is a series of five distinct, non-linear stages that fall under two major headings (Weinstein ND, 1993; Weinstein ND, Rothman A, and Sutton S, 1998; Weinstein ND and Sandman PM, (in press)).

There are five stages in the precaution adoption process model (Figure 2). Stages 1 through 3 relate to beliefs about personal susceptibility to a health threat. Stages 4 and 5 are associated with personal decision and action. Each individual stage is dichotomous, indicating that either the individual has reached that particular stage or not. The determinants that motivate a person into a given stage and from one stage to the next may be numerous, reflecting the differences that exist in individuals' personal experience, belief origins, and perceptions of vulnerability to a given hazard. Thus, there is not necessarily a linear relationship between stages. The determinants that move one person into a stage may be qualitatively different from the determinants that may influence another person (Weinstein ND 1993; Weinstein ND, Rothman A, and Sutton S 1998; Weinstein ND and Sandman PM (in press)).

Knowledge that a hazard exists is necessary for an individual to begin to think about taking action. Thus, prior to Stage 1, an individual will have no knowledge of the health hazard and, therefore, be unaware of any precautions to adopt. Beginning with Stage 1 the individual will have become aware of the health hazard. In the context of tick-borne infections, the dichotomy "I have heard about Lyme disease" vs. "I've never heard about Lyme disease" illustrates basic knowledge, but not necessarily a full understanding of the hazards presented by this tick-borne infection. The major determinants for how an individual enters Stage 1 are communication about the hazard, e.g., media, interpersonal; and experience with hazard, e.g., having had Lyme disease or knowing someone who has; and awareness that a precaution exists (Weinstein ND

and Sandman PM (in press); Weinstein ND 1982).

Stage 2 represents the level where a person has moved beyond basic knowledge and states the belief that there is a significant likelihood that the hazard affects others. At this stage, the statement "Lyme disease is a problem for quite a few people" vs. "Lyme disease is a rare problem" is illustrative. The major determinants to motivate an individual to move from Stage 1 to Stage 2 include: credibility and clarity of communications about the prevalence of the hazard, e.g., a series of news reports on Lyme disease, newspaper articles about an abundance of ticks this season, or government warnings posted in parks or recreation areas where infected ticks have been found; experience with the hazard, e.g., hearing others talk about the number of ticks they have seen this summer; and, the belief that a precaution is generally effective. However, general facts about a health threat, e.g., what Lyme disease is, where it is most prevalent, and how it causes illness, appear to be insufficient in moving an individual beyond Stage 2. By contrast, personal experience with the hazard as well as peer actions regarding the hazard and available precautions appear to affect an individual's motivation to move from Stage 2 to Stage 3 (Weinstein ND 1988; Weinstein ND, Rothman A, and Sutton S 1998; Weinstein ND and Sandman PM (in press)). Weinstein has demonstrated that progression from Stage 2 to Stage 3 may be hampered by "optimistic biases," that is erroneous beliefs held by a person that risk to self is less than the risks to others (Weinstein ND 1989). Based on Weinstein's studies, optimistic biases appear to occur in relation to threats a person seldom

encounters and believes to be preventable (Weinstein ND 1980).

When a individual acknowledges personal risk for the hazard the move has been made to Stage 3. At this stage an individual may indicate, "There is a real chance that I could have infected ticks around my home that can transmit the Lyme disease bacteria" vs. "There isn't much of a chance that ticks infected with the bacteria that cause Lyme disease are present around my home." The major determinants of entering Stage 3 include risk factor information, e.g., more than basic knowledge of the agent and vector of Lyme disease, such as seasonality of risk for infection; personalized risk information, e.g., a belief that a precaution would be personally effective or the severity of the disease is understood; experience with the hazard, e.g., the individual has known about Lyme disease over time, has gathered or knows where to obtain information on Lyme disease, can identify the physical appearance of the putative tick vectors in their three life stages, understands that an abundance of deer may increase the prevalence of deer ticks; and information about peer status on risk factors, e.g, the individual has seen neighbors erecting deer fencing, spraying their lawns with acaracides, and knows that nearby sports camps require children participants to use DEET-containing insect repellent when hiking in wooded or grassy areas known to be tick habitats (Weinstein ND 1988; Weinstein ND, Rothman A, and Sutton S 1998; Weinstein ND and Sandman PM (in press)).

Stages 4 and 5 represent an individual's decision to adopt a precaution and the actual behavior of adoption, respectively (Weinstein ND 1988). For example, an

individual who has reached Stage 4, the decision or intent to adopt a precaution, would agree with the statement, "I plan to spray acaricides on my lawn, use insect repellent when I'm in the woods, tuck my pants into my socks, etc., in order to prevent tick bites." The major determinants that govern an individual reaching Stage 4 include beliefs about the seriousness of the threat, perceived personal severity, the behaviors of others, the salience of short- and long-term threats, beliefs about precautions, effectiveness of precautions for self, barriers to adopting the precautions, the behaviors of others indicating desirability of the precaution, the salience of the short- and long-term costs, and knowledge of alternative precautions being available (Weinstein ND 1988; Weinstein ND, Rothman A, and Sutton S 1998; Weinstein ND and Sandman PM (in press)). In terms of Lyme disease prevention, PAPM posits that necessary conditions for an individual to reach Stage 4 are beliefs by the individual that he/she is personally at risk for Lyme disease, that the hazard posed by Lyme disease would have negative personal consequences, and that the precautions advocated for preventing Lyme disease would be personally effective. The individual, in deciding to act, would also take into consideration the magnitude of the severity and likelihood of Lyme disease, the degree of effectiveness of precautions recommended to prevent tick bites, and the costs (e.g., financial, opportunity, short and long term) that could be incurred. While there is no consensus as to whether these factors are joined in additive, multiplicative fashion, or some combination thereof, in deciding to adopt a precaution it appears that more weight is given outcomes that appear certain as opposed to

outcomes that are probabilistic (Weinstein ND and Nicolich M (1992, unpublished manuscript)). In PAPM, the individual who answers, to his or her satisfaction, the questions of susceptibility, severity, and cost, as discussed above, would meet the necessary and sufficient conditions to decide to adopt one or more precautions to take preventive action, i.e., progress to Stage 4 (Weinstein ND 1988; Weinstein ND, Rothman A. and Sutton S 1998; Weinstein ND and Sandman PM (in press)).

According to the precaution adoption process model, arrival at Stage 5 signifies action by taking the precaution. This can be illustrated by agreement with the statement, "I have applied acaricides to my lawn to kill infected ticks that may be present and thereby prevent tick bites on me and my family." The major determinants for arrival at Stage 5 are factors determining the strength of the intention to act (all those listed in Stage 4), the complexity of the precaution, the ease of obtaining information required to carry out the precaution, the time, effort, and resources available in the context of competing life demands, the time until the hazard appears, the opportunities that decrease the cost of acting, reminders of the threat, and reminders to take the precaution (Weinstein ND and Sandman PM (in press)). In an ideal world, an individual would have unlimited resources to carry out the precaution. All ideas about how to prevent the threat would be ranked by priority and given rational and thoughtful consideration, the costs versus the benefits of action would be studied and weighed with the result that good ideas are acted upon and bad ideas are discarded (Weinstein ND and Sandman PM (in press)). However, in the real world there are numerous

barriers and constraints to action on an individual's time and resources, including the seemingly mundane responsibilities of daily life. Ideas about how to prevent a threat may be given rational and thoughtful consideration but may not receive adequate or immediate attention because competing demands on time and resources relegate that action to other priorities (Weinstein ND and Sandman PM (in press)). For example, an individual may intend to apply acaricides to the lawn but competing demands may demote action on that decision. For example, an individual's children may need to be shuttled to soccer, baseball, and/or gymnastics events, and the long checkout lines at the home improvement store during the weekends are barriers to the individual allocating time to purchase the insecticide product and obtain the rental of spreader or sprayer equipment to properly apply the pesticide. Furthermore, competing demands on the individual's financial resources render excessive the money needed to employ a professional pesticide company to apply the acaricides. Thus, the action remains an intention and the person does not progress beyond Stage 4.

In summary, the health-protective behavior an individual takes in order to prevent, moderate or reduce exposure to vector-borne infectious disease agents can be well illustrated by PAPM. However, in order to use a stage model of health protective behavior, such as PAPM, data must be collected such that individual's are placed in a given stage with changes or movements from one stage to the next measured prospectively (Weinstein ND, Rothman A, and Sutton S 1998; Weinstein ND and Sandman PM (in press)). Such an approach is beyond the scope of the present study

which was designed to establish a baseline dataset that would be representative of and generalizable to the U.S. adult population regarding knowledge, attitudes, beliefs, and practices regarding ticks and mosquitoes and Lyme disease and arboviral encephalitis, respectively. Further research employing a stage model would be an appropriate follow-up to the current study.

Emerging Vector-Borne Infectious Diseases

Lyme disease

Human behavior and demographics, ecologic changes, international travel and commerce, technology and industry, microbial adaptation, and a breakdown in public health measures are interrelated factors in the emergence of new infectious diseases and the re-emergence of old plagues, including those with arthropod vectors, such as mosquitoes, ticks, and fleas (Walker DH and Dumler JS 1996; Morse SS 1995; Walker DH et al. 1996; Garrett L 1995). Lyme disease is an important emerging infectious disease, accounting for more than 90% of all reported cases of vector-borne illness in the United States (Dennis DT 1998; Nadelman RB and Wormser GP 1998; Rahn DW and Evans J 1998; Kalish R 1993). Early in the characterization of Lyme disease, epidemiological studies suggested that an infectious agent was transmitted by an arthropod vector. It is now known that the black-legged tick *Ixodes scapularis* is the primary vector in Lyme disease-endemic counties in the northeast and upper midwestern states and that the western black-legged tick *I. pacificus* transmits the bacterium along the northern West Coast (Centers for Disease Control and Prevention 1997c). The infectious agent is the spirochete *Borrelia burgdorferi*, acquired from the bite of an infected tick (Pfister HW, Wilske B, and Weber K 1994). Lyme disease was first described in the United States in 1977 as a chronic arthritis among children living in Old Lyme, Connecticut (Steere AC et al. 1977). A national standardized case definition was approved in 1990 by the Council of State and Territorial Epidemiologists

and implemented nationwide in 1991 (Wharton M et al. 1990).

The reported number of cases of Lyme disease increased from 9,470 in 1991 to 17,730 in 2000, with more than 132,000 cumulative cases reported during this period (Figure 3) (Centers for Disease Control and Prevention 2002). Lyme disease has been reported by 49 states, the District of Columbia, and Guam (2 cases), yielding a crude mean annual incidence of 5.1 reported cases per 100,000 persons, ranging from 0 to 67.9 per 100,000 persons with a median of 0.6 (Centers for Disease Control

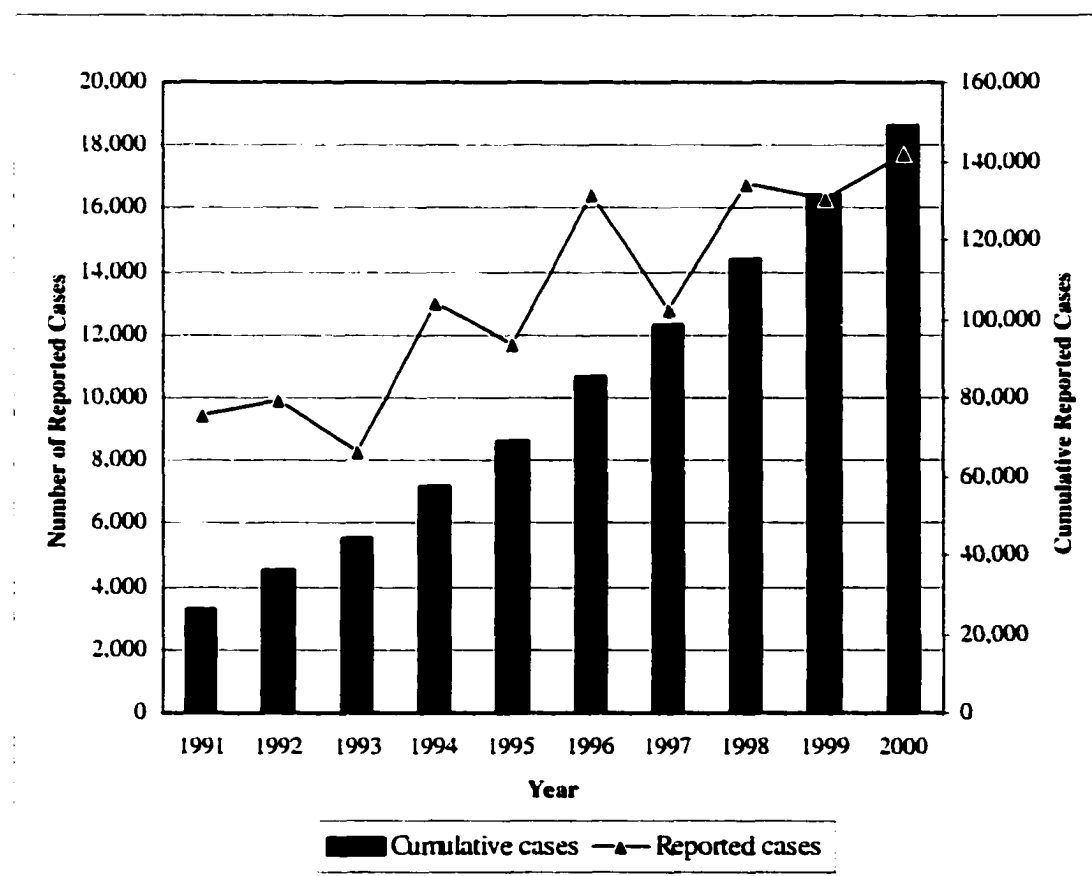


Figure 3. Number of reported and cumulative cases of Lyme disease, 1991-2000, United States (Centers for Disease Control and Prevention, 2002).

and Prevention 2002). In 1998, the year of this study, over 90% of Lyme disease cases were reported by 10 states (Appendix C, Table 1).

The biology, ecology, and epidemiology of Lyme disease is well documented (Steere AC 1989; Barbour AG and Durland F 1993; Piesman J et al. 1987; Falco RC and Fish D 1988; Schulze TL et al. 1991; Smith RP Jr et al. 1992; Kalish R 1993). However, a total of 6,752 cases (7.6%) in 1998 were reported from 39 states with low or no known Lyme disease risk (Centers for Disease Control and Prevention 2000c). Ticks are also vectors for other infectious and potentially fatal illnesses in the U.S., including human granulocytic ehrlichiosis, babesiosis, and Rocky Mountain spotted fever (Centers for Disease Control and Prevention 1996b; Centers for Disease Control and Prevention 1995c; Fishbein DB, Dawson JE, and Robinson LE 1994; Centers for Disease Control and Prevention 1989; Lederberg J 1997; Varde S, Beckley J, and Schwartz I 1998; Abramson JS and Givner LB 1999; Paddock CD et al. 1999; Eng TR, Harkess JR, and Fishbein DB 1990). Not surprisingly, the number of popular press articles on Lyme disease increased steadily between 1982 and 1998 (Figure 4). However, studies on the prevalence of behavioral risk factors for tick-bite and Lyme disease prevention are relatively few (Hallman W et al. 1995; Herrington JE 2002; Brown SW et al. 1992; Cartter ML et al. 1989; Shadick NA et al. 1997; Schwartz BS and Goldstein MD 1990).

Prevention of tick bites may vary by tick species due to geographic location, seasonality in breeding, questing behavior, and other environmental and human

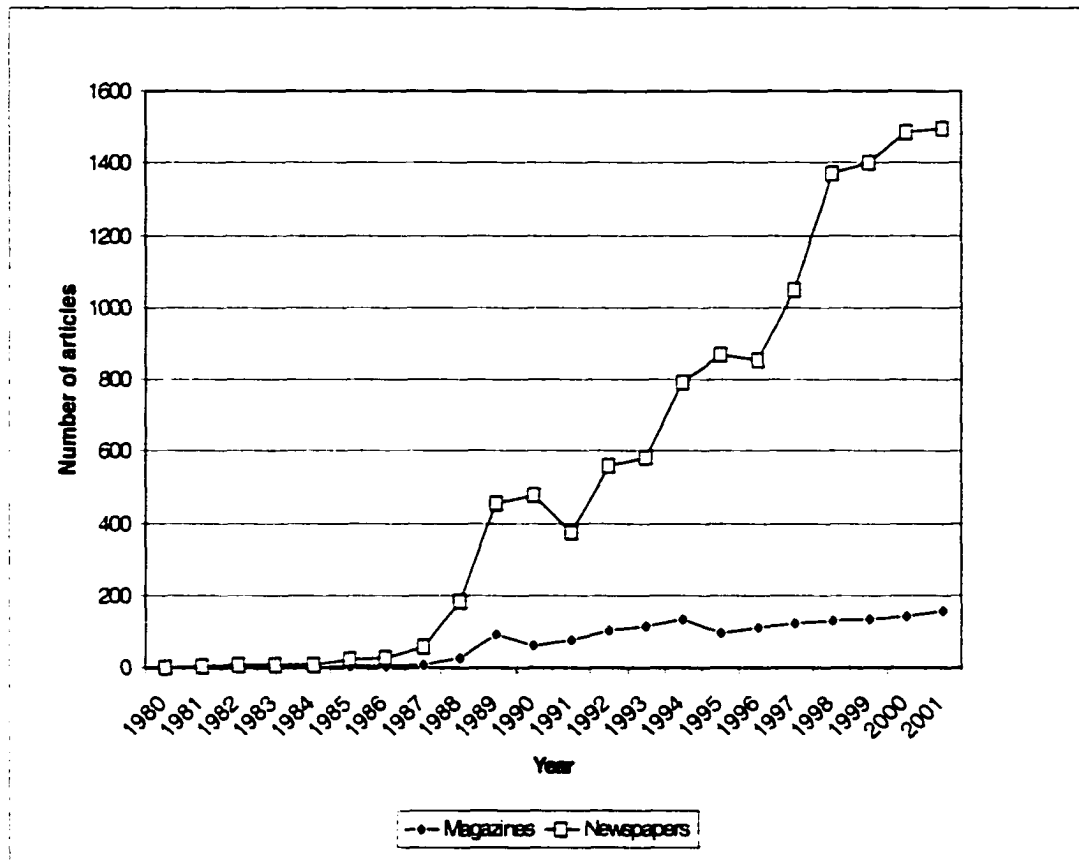


Figure 4. Lyme disease articles in magazines and newspapers, United States, 1980-2001 (Lexis-Nexis Academic Universe, 2002).

behavioral factors that influence human-tick exposure. However, tick-bite precautions are generally consistent across tick species, such as avoidance of tick habitat, use of insect repellents, light-colored clothing to better see attached ticks, physical body checks for ticks hidden under clothing, and landscape management, including use of acaricides (Rahn DW and Evans J 1998; Barbour AG 1996; Herrington JE 1995; Schulze TL, Jordan RA, and Hung RW 1995; Schulze TL et al. 1994; Hayes EB et al. 1999; Connecticut Public Television 1997). Nevertheless, systematic investigations are needed to improve our understanding of the behavioral epidemiologic factors, such as

knowledge, attitudes, values, perceived needs and abilities that motivate or prevent individuals from taking precautions against tick bites, and Lyme disease in particular. Although a notifiable disease nationwide since 1991, Lyme disease is often misdiagnosed and is most likely under reported (Centers for Disease Control and Prevention 1993; Mahr P, Ertel S, and Carter M 1994) due to a lack of knowledge and understanding by medical providers and at-risk populations (Steere AC et al. 1993; Steere AC et al. 1994).

A combination of human and environmental factors continue to bring white-tailed deer, a source for blood meals for adult ticks, and the white-footed mouse Peromyscus leucopus, the natural reservoir host for the agent as well as a source of blood meals for immature ticks, into closer proximity with humans, resulting in greater exposure and increased disease incidence (Dennis DT 1998; Barbour AG 1996; Barbour AG and Durland F 1993; Schulze TL, Jordan RA, and Hung RW 1995; Schulze TL et al. 1994). The pathogenic agent of Lyme disease, the spirochete B. burgdorferi, has an incubation period from infection to onset of signs and symptoms ranging typically from 7 to 14 days but may be as short as 3 days and as long as 30 days (Burgdorfer WA et al. 1982; Rahn DW and Evans J 1998; Barbour AG 1996; Barbour AG and Durland F 1993). The spirochetes are transmitted by an infected tick while taking a blood meal, usually after 48 hours or more of attachment (Piesman J et al. 1987). The pathogenesis of Lyme disease results from inoculation of B. burgdorferi into the skin during feeding with dissemination by cutaneous, lymphatic and

blood-borne routes (Nadelman RB and Wormser GP 1998; Rahn DW and Evans J 1998; Barbour AG 1996). The bacterium is not known to produce toxins or cause direct tissue damage (Nadelman RB and Wormser GP 1998). An inflammatory response to the organism is thought to cause erythema migrans, a “bull’s-eye” skin rash, with further dissemination to other body sites, primarily the musculoskeletal and neurologic systems (Rahn DW and Evans J 1998).

Erythema migrans is a characteristic of infection in 60 to 80 percent of infected persons, though some infected individuals may be asymptomatic, express no erythema migrans rash, or manifest only non-specific symptoms such as fever, headache, fatigue, and myalgia (Nadelman RB and Wormser GP 1998; Rahn DW and Evans J 1998; Kalish R 1993). Signs of early disseminated infection usually occur days to weeks after the appearance of a solitary or multiple erythema migrans lesions and include disease of the nervous system, the musculoskeletal system, or the heart (Nadelman RB and Wormser GP 1998; Rahn DW and Evans J 1998; Kalish R 1993). Lymphocytic meningitis, cranial neuropathy (especially facial nerve palsy), and radiculoneuritis characterize early neurologic manifestations (Rahn DW and Evans J 1998). Migratory joint and muscle pains with or without objective signs of joint swelling characterize musculoskeletal manifestations (Rahn DW and Evans J 1998). Cardiac manifestations are rare but may include myocarditis and transient atrioventricular blocks of varying degree (Rahn DW and Evans J 1998; Kalish R 1993). Left untreated, B. burgdorferi infection may progress to late disseminated disease weeks to months after infection.

Intermittent swelling and pain of one or a few joints, usually large, weight-bearing joints such as the knee, chronic axonal polyneuropathy, or encephalopathy, the latter usually manifested by cognitive disorders, sleep disturbance, fatigue, and personality changes may characterize late disseminated disease (Shadick NA et al. 1994). Morbidity may be severe, chronic, and disabling, though with low reported frequency. Moreover, an ill-defined post-Lyme disease syndrome appears to occur in some persons following treatment for Lyme disease. Lyme disease is rarely, if ever, fatal (Barbour AG 1996).

Diagnosis of Lyme disease is based primarily on clinical assessment (Steere AC 1989; Steere AC et al. 1994; Rahn DW and Evans J 1998; Barbour AG 1996; Pfister HW, Wilske B, and Weber K 1994). Serologic testing provides valuable supportive diagnostic information in patients with endemic exposure and objective clinical findings that suggest later stage disseminated Lyme disease (Steere AC 1989; Steere AC et al. 1994; Rahn DW and Evans J 1998; Barbour AG 1996; Pfister HW, Wilske B, and Weber K 1994). When serologic testing is indicated, CDC recommends testing initially with a sensitive first test, either an enzyme-linked immunosorbent assay (ELISA) or an indirect fluorescent antibody (IFA) test, followed by testing with the more specific Western immunoblot (WB) test to corroborate equivocal or positive results obtained with the first test (Centers for Disease Control and Prevention 1995d). Risk factors for contracting Lyme disease in the United States include living in an endemic area for both the vector tick (*Ixodes scapularis* and *Ixodes pacificus*) and infectious agent *B. burgdorferi* (Dennis DT et al. 1998), climatic season (late spring and summer in the

northeast and midwest), exposure to the nymphal tick stage, and duration of tick attachment being 48 hours or more (Dennis DT 1998; Rahn DW and Evans J 1998; Piesman J et al. 1987).

Generally, Lyme disease is successfully managed with antibiotics (Steere AC et al. 1994; Rahn DW and Evans J 1998; Barbour AG 1996; Pfister HW, Wilske B, and Weber K 1994). Treatment for 3-4 weeks with doxycycline or amoxicillin is generally effective in early disease (Steere AC et al. 1994; Rahn DW and Evans J 1998; Barbour AG 1996). Cefuroxime axetil or erythromycin can be used for persons allergic to penicillin or who cannot take tetracyclines (Steere AC et al. 1994; Rahn DW and Evans J 1998; Barbour AG 1996). In late disease with objective neurologic manifestations, treatment with intravenous ceftriaxone or penicillin for 4 weeks or more may be required, depending on disease severity. Treatment failures have been observed and retreatment may be necessary (Pfister HW, Wilske B, and Weber K 1994; Rahn DW and Evans J 1998).

Ehrlichiosis

Ixodes scapularis, the principal vector of Lyme disease, also transmits a newly discovered rickettsial agent that is similar to the bacterium Ehrlichia equi (Bakken JS et al. 1996) and causes human granulocytic ehrlichiosis (HGE), a potentially fatal infection (Bakken JS et al. 1994; Bakken JS 1998; Eng TR, Harkess JR, and Fishbein DB 1990). The Lone Star tick (Amblyoma americanum) is also a putative vector for HGE

(Anderson BE et al. 1993). Since 1993, over 500 cases of HGE have been reported in the United States, mainly in the upper midwestern and Northeastern states, but also in northern California and Florida (Walker DH and Dumler JS 1996; Fishbein DB, Dawson JE, and Robinson LE 1994; Bakken JS 1998). Active epidemiologic surveillance in New York state identified 100 HGE cases in 1996 (Centers for Disease Control and Prevention 1996b; Centers for Disease Control and Prevention 1995c). HGE appears to have an epidemiology similar to Lyme disease but, as a newly emerging infectious disease, is poorly understood by the medical community and the at-risk public (Bakken JS et al. 1994; Fishbein DB, Dawson JE, and Robinson LE 1994; Dumler JS and Bakken JS 1995; Walker DH and Dumler JS 1996).

Rocky Mountain spotted fever

Another rickettsial disease, Rocky Mountain spotted fever (RMSF), is transmitted by the common dog tick Dermacentor variabilis in the eastern and southern states, the wood tick Dermacentor andersoni in the northwest, and the Lone Star tick Amblyoma americanum in the southwest (Abramson JS and Givner LB 1999; Paddock CD et al. 1999). Prior to the introduction of tetracycline and chloramphenicol in the late 1940s, as many as 30% of persons infected with R. rickettsii died (Dumler 1998). Effective antibiotic therapy has dramatically reduced the number of deaths caused by RMSF (Paddock CD et al. 1999). In 1995, 590 cases of RMSF were reported in the U.S. (Centers for Disease Control and Prevention 1996c). Rocky Mountain spotted

fever remains a serious and potentially life-threatening infectious disease today with deleterious long-term sequelae (Archibald LK and Sexton DJ 1995). Despite the availability of effective treatment and advances in medical care, approximately 3% to 5% of individuals who become ill with Rocky Mountain spotted fever die from the infection (Archibald LK and Sexton DJ 1995; Dumler 1998). This may be attributed to lack of knowledge regarding the signs and symptoms by patients and medical personnel (Dumler 1998).

Arboviral encephalitides

Arboviral encephalitides are viral infections transmitted by infected mosquito vectors. Passive arboviral surveillance data collected in the U.S. reported 8,211 cases of arboviral encephalitis from 1964 through 2001,^c of which St. Louis encephalitis comprised 54.8% of reported cases, LaCrosse encephalitis 34.5%, Western equine encephalitis 7.7%, eastern equine encephalitis 2.2%, and West Nile virus 0.8%, respectively. The trend of arboviral encephalitides reveals St. Louis encephalitis and LaCrosse encephalitis infections to be the most frequently reported of the four major encephalitides, with an annual mean of 128 and 72 cases, respectively, for the 38 year

^c Data for 2001 are preliminary (Campbell G, CDC, personal communication).

period (Figure 5) (Centers for Disease Control and Prevention 1998g; Centers for Disease Control and Prevention 1998e; Centers for Disease Control and Prevention 1998d; Centers for Disease Control and Prevention 1998f). Unlike morbidity data, arboviral encephalitides mortality data are not routinely collected by the National Electronic Telecommunications System for Surveillance (NETSS) (Centers for Disease Control and Prevention 1995a). Symptoms of arboviral encephalitis infection include headache, fever, nausea, dehydration, seizures, paralysis, coma, and death (rarely) (Centers for Disease Control and Prevention 1999g; Centers for Disease Control and

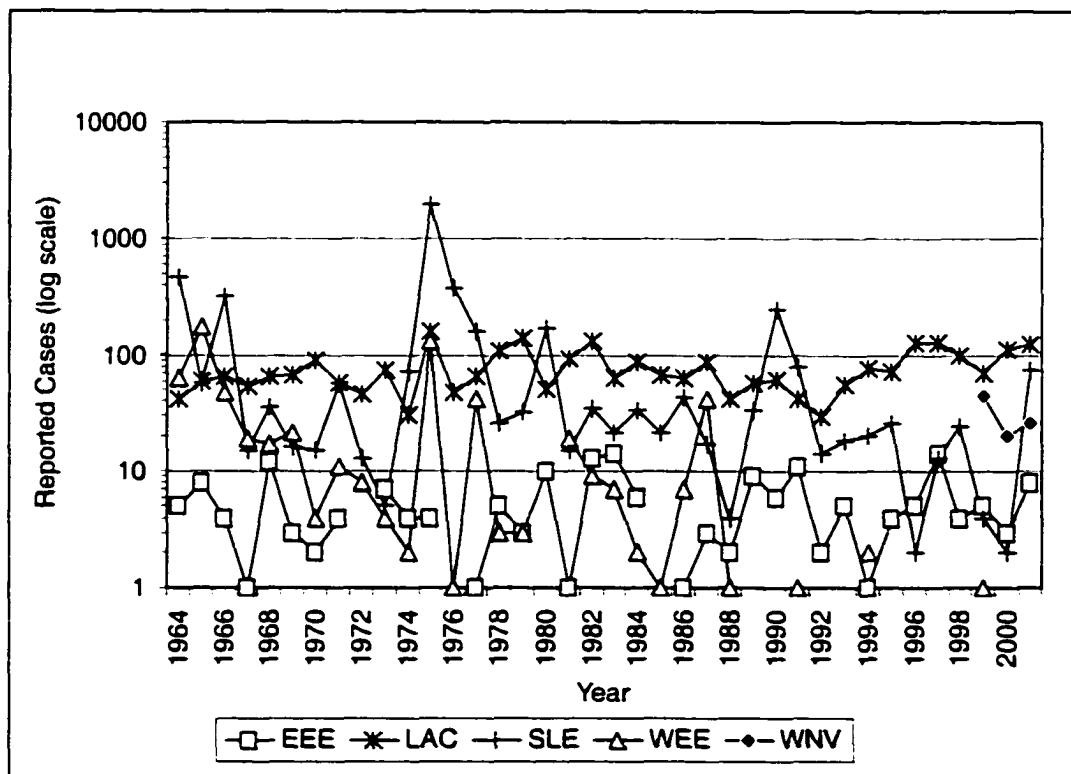


Figure 5. Reported cases of eastern equine encephalitis (EEE), Lacrosse encephalitis (LAC), St. Louis encephalitis (SLE), Western equine encephalitis (WEE), and West Nile virus (WNV), United States, 1964-2001 (Center for Disease Control and Prevention, 1999a-e).

Prevention 1997a; Centers for Disease Control and Prevention 1999c). Children and the elderly are at greatest risk for poor clinical outcome (Centers for Disease Control and Prevention 1999g; Centers for Disease Control and Prevention 1997a). Long-term sequelae of encephalitis infection include nervousness, learning difficulties, auditory and visual degradation, hyperactivity, personality problems, emotional instability, and seizures (Centers for Disease Control and Prevention 1999g; Hayes C 1989; Centers for Disease Control and Prevention 1997a; Centers for Disease Control and Prevention 2000a).

West Nile viral encephalitis

In August 1999, an arboviral encephalitis outbreak was recognized in New York City and in contiguous counties in New York state. Positive serologic findings in human cerebrospinal fluid (CSF) and serum samples initially led to the outbreak being attributed to St. Louis encephalitis (SLE) virus (Centers for Disease Control and Prevention 1999c). Further analysis of virus recovered from human, avian, and mosquito samples revealed West Nile virus (WNV), an agent (Shope RE 1999) previously not known to occur in North America (Centers for Disease Control and Prevention 1999g; Hayes C 1989; Centers for Disease Control and Prevention 1999c; Hubálek Z and Halouzka J 1999). By November 1999, 56 (31 confirmed and 25 probable) cases of WNV infection had been identified, including seven deaths (Centers for Disease Control and Prevention 1999c). It was further determined that WNV

overwintered in mosquito vectors in the Northeastern U.S., primarily Culex species (Centers for Disease Control and Prevention 2000d; Centers for Disease Control and Prevention 2000b). Active surveillance in 1999 for WNV in 17 states along the Eastern seaboard and Gulf of Mexico revealed WNV infection in mosquitoes, sentinel chicken flocks, wild birds, and potentially susceptible mammals, such as horses and humans (Centers for Disease Control and Prevention 2000e).

During 2000, 14 persons from New York state and four from New Jersey were hospitalized with severe central nervous system illnesses caused by WNV. The age of these 18 patients ranged from 36 to 87 years (mean: 62 years) with 67% being men. The onset dates for illness in this population were in late summer (July 20 to September 13). There was one fatality among the 18 patients (case fatality rate: 6%). Another patient was in a persistent vegetative state (Centers for Disease Control and Prevention 2000g; Centers for Disease Control and Prevention 2000f; Centers for Disease Control and Prevention 2001a). The WNV epizootic has persisted in the four states originally affected in 1999 (Connecticut, Maryland, New York, and New Jersey) and had expanded in 2000 into eight additional states (Delaware, Massachusetts, New Hampshire, North Carolina, Pennsylvania, Rhode Island, Vermont, and Virginia) and the District of Columbia. While 18 humans with encephalitis attributed to WNV were reported in 2000 compared with 62 in 1999, less than 1% of infected persons will demonstrate severe neurologic illness, suggesting that approximately 2000 persons may have been infected, but were asymptomatic during 2000 (Centers for Disease Control

and Prevention 2000g; Centers for Disease Control and Prevention 2000f; Centers for Disease Control and Prevention 2001a). It is anticipated that widespread WNV epizootic activity will most likely persist and expand in the United States with larger outbreaks of WNV infection and human illness possible (Centers for Disease Control and Prevention 2000a). Thus, active surveillance for the spread of WNV in animals and humans, as well as behavioral risk factors that may increase or decrease the risk of human and animal illness, will be important in the control of WNV exposure.

Humans are at risk for WNV because female mosquitoes require blood meals, a biological and evolutionary behavior which provides nourishment for the female's eggs and, thus, furtherance of the species (Ehrlich PR 2000) while male mosquitoes feed only on plant nectars. Prevention of female mosquito bites may vary by mosquito species due to geographic location, biting and resting behaviors, including time of day, seasonality in mosquito abundance, and other environmental and/or human behavioral factors that may influence human-mosquito exposure (Nasci RS et al. 2000; Nasci RS et al. 1993; Nasci RS and Moore CG 1998; Nasci RS 1995). However, mosquito-bite precautions generally remain constant across mosquito species, such as through avoidance of mosquito habitat, use of insect repellents on skin and clothing, use of clothing to reduce total surface area of exposed skin, use of clothing material that is thick and of tight weave to prevent the mosquito's stylets from penetrating to the skin's surface, landscape management to minimize containers/locations favorable for mosquito egg laying, and use of insecticides to kill larval and adult mosquitoes (Nasci RS 1995).

Systematic investigations are needed to improve our understanding of the behavioral epidemiologic factors, such as knowledge, attitudes, values, perceived risks and coping abilities, that motivate or prevent individuals from taking precautions against mosquito bites.

An alarming aspect of the WNV outbreak was the occurrence of a novel viral agent in the highly and densely populated NYC area, with an estimated 7.2 million people living in an area of approximately 350 square miles (U.S. Census Bureau 1997b), where the mosquito vector and host reservoir, wild birds, are ubiquitous. Once it was determined that the infectious agent was transmitted by mosquitoes, NYC officials acted swiftly to mobilize ground and air insecticide spraying for adult and larval mosquitoes, distribution of DEET-containing insect repellent^d to fire stations and other public facilities in affected neighborhoods, and to provide public information on how to reduce risk of mosquito bites and possible infection with WNV (Centers for Disease Control and Prevention 1999g; Centers for Disease Control and Prevention 2000b). At the same time CDC, NYC, and surrounding local health departments worked in concert to mobilize active surveillance and case finding activities in order to characterize the geographic extent of the epidemic, the risk factors for illness, and to develop methods for containment of the epidemic (Centers for Disease Control and Prevention 2000a; New York City Department of Health 2001; Connecticut Department of

^d*N,N*-diethyl-*m*-toluamide.

Environmental Protection 2002).

Susceptibility and fear were expressed by NYC metropolitan area residents immediately following the initial public announcement by NYC officials regarding a new mosquito-borne virus in the New York City area. CDC received over 2200 email inquiries in November 1999 requesting risk and prevention information on WNV (Centers for Disease Control and Prevention 1999f). The NYC Department of Health logged over 50,000 phone call inquiries in the 4 weeks following the NYC announcement (Fine A and Layton M 1999). During the period January 1, 1999 to September 30, 2001, there were 3636 newspaper and magazine articles published with the keywords "West Nile virus" in the title or text body (Figure 6) (Lexis-Nexis Academic Universe 2001). The greatest proportion (65%) of articles on West Nile virus were published in the Northeastern region. Media attention may have served to amplify the salience of the outbreak for NYC metropolitan residents. It is not surprising that a novel and potentially fatal infectious agent transmitted by a common house dwelling mosquito in a highly urban environment would generate immediate concern about the risk for infection, as illustrated by the increasing frequency of popular news articles. Such anecdotal information should be more fully described through empirical inquiry in order to quantify individuals' knowledge, attitudes, beliefs, and behaviors regarding mosquitoes and mosquito-transmitted diseases.

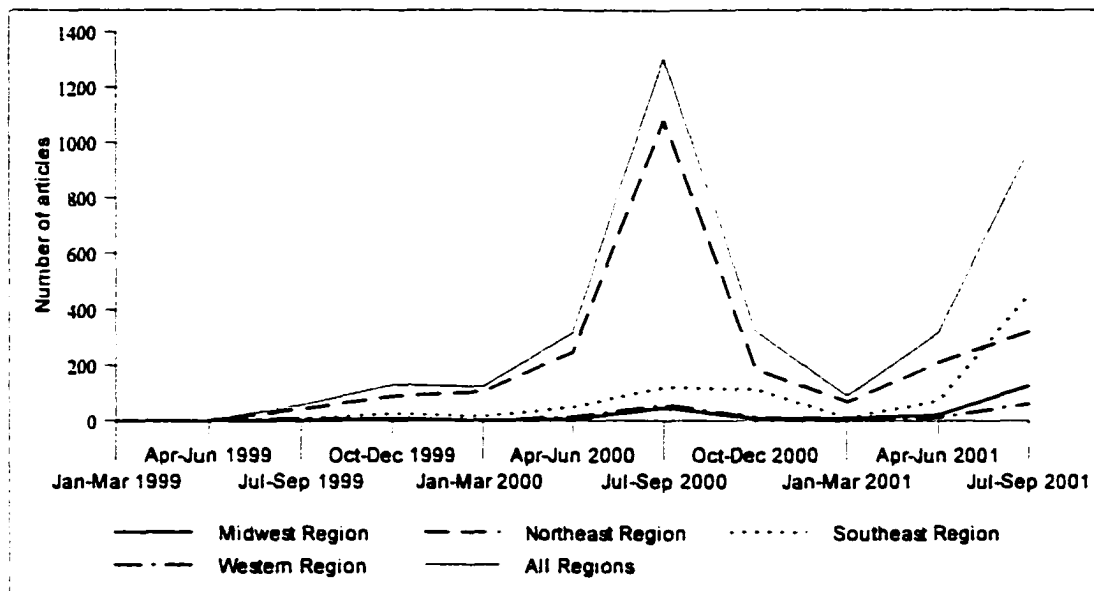


Figure 6. Number of articles published in newspapers and magazines with keywords “West Nile virus” in the title or text body, January 1, 1999 through September 30, 2001, United States. Midwest Regional Sources: Illinois, Iowa, Indiana, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin; Northeast Regional Sources: Connecticut, Delaware, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont; Southeast Regional Sources: Alabama, Arkansas, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, West Virginia; Western Regional Sources: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oklahoma, Oregon, Texas, Utah, Washington, Wyoming (Lexis-Nexis Academic Universe, 2001).

Dengue fever and dengue hemorrhagic fever

Dengue is a vector-borne viral illness transmitted in tropical urban and periurban settings principally by the mosquito Aedes aegypti and, to a lesser extent, in rural areas by the mosquito Aedes albopictus, both of the Stegomyia subgenus (Gubler DJ 1997a). In the early years of the 20th century, yellow fever, another hemorrhagic disease, was found to be transmitted by mosquitoes (Shope RE 1999). In 1903,

Graham discovered that dengue illness could be transmitted by mosquitoes, based on experiments using human volunteers (Graham H 1903). Three years later, Bancroft demonstrated that Aedes aegypti could transmit dengue to naive human subjects after the mosquitoes had fed on a person ill with dengue fever (Bancroft TL 1906). During the next 40 years it was shown that other mosquitoes were also efficient vectors for dengue viruses, including Aedes albopictus, Aedes polynesiensis, and Aedes scutellaris, though Aedes aegypti is considered to be the principal vector for dengue due to its anthropophilic behavior (Halstead SB 1990; Gubler DJ 1997a; Halstead SB 1994; Innis BL 1995).

Aedes aegypti is common in central and south America and the Gulf Coast states of the United States (World Health Organization 1998; Innis BL 1995; Gubler DJ 1997b). After an absence of 35 years, autochthonous dengue transmission has occurred five times in the continental United States: 1980, 1986, 1995, 1999, and 2001 (Gubler DJ 1997a; Centers for Disease Control and Prevention 1996a; Centers for Disease Control and Prevention 1999b). Active surveillance along the U.S.-Mexico border in Texas identified seven cases of autochthonous dengue fever in 1995 (Centers for Disease Control and Prevention 1996a). During January to July 1999, approximately 300 to 325 dengue cases were reported from Nuevo Laredo, Tamaulipas, Mexico (1999 population: 274,000), a city across the Rio Grande river from Laredo, Texas (Centers for Disease Control and Prevention 2001c). Warnings about dengue were broadcast to medical care providers and the public. Mosquito

reduction and personal protection information was distributed through health fairs and schools. Surveillance information exchange increased dramatically between health officials in Laredo, TX and Nuevo Laredo, Mexico (Centers for Disease Control and Prevention 2001c). Prior to the warnings being issued no suspected cases were reported. However, 161 suspected dengue cases were reported during mid-August through December 1999 (Centers for Disease Control and Prevention 2001c). Of these, 18 cases tested positive for dengue (Centers for Disease Control and Prevention 2001c). No positive cases were reported from Laredo, TX in 2000 (Centers for Disease Control and Prevention 2001c). Dengue has also been reported in Florida among persons who have traveled to the Caribbean where dengue is endemic on many islands (Centers for Disease Control and Prevention 1999b).

Moreover, beginning in 2001 and through February 2002, 108 cases of locally acquired dengue fever were confirmed in the state of Hawaii for the first time in 50 years (Duffy DC 2001; Sasaki DM and Tom T 2002). Dengue is endemic in Puerto Rico (Gubler DJ 1997a) with the number of reported cases during five nonepidemic years (1992, 1993, 1995, 1996, and 1997) ranging from 4,645 to 11,078 (mean rate of 2.0 cases per 1000 population). During the 1994 epidemic, 23,693 cases were reported (6.7 per 1000 population) while during the recent 1998 epidemic, there were 9,803 cases reported (2.8 per 1000 population) of which 4,677 (47.7%) were diagnosed as dengue by virologic or serologic testing, 526 (5.4%) were negative, and 4600 (46.9%) were indeterminate (Centers for Disease Control and Prevention

1998h).

There is no vaccine nor curative treatment for dengue fever or dengue hemorrhagic fever (DHF). Geographically, the spread of dengue virus has increased dramatically in the past five decades following World War II, resulting in dengue illness being prevalent in practically every tropical country in the world (Halstead SB 1990; Halstead SB 1994; Gubler DJ 1998). Although the hemorrhagic form of dengue was documented as early as 1780, epidemic occurrences of DHF were relatively infrequent until the second half of the 20th century when significant ecologic and demographic disruptions occurred in the south Pacific and southeast Asian theaters during and following World War II (Gubler DJ 1998; Gubler DJ 1997b). Because of the war, a significant number of new and ideal Aedes aegypti mosquito larval habitats were created in close proximity to humans. Piped water systems were destroyed, necessitating the use of water storage containers that, inadvertently, favored successful egg laying, incubation, and development of Aedes aegypti (Gubler DJ 1998; Gubler DJ 1997b). Rapid movement of mosquito eggs and mosquitoes increased with military activities, expanding the geographic distribution of dengue virus in the south Pacific and southeast Asian regions (Gubler DJ 1998; Gubler DJ 1997b). Abandoned and destroyed military equipment and other non-biodegradable refuse created additional larval breeding habitats (Gubler DJ 1998; Gubler DJ 1997b).

The worldwide burden of morbidity from dengue fever and DHF is substantial, with disease occurring in over 100 countries and territories and affecting the health of

more than 2.5 billion people (World Health Organization 1998; Gubler DJ 1997a). Annual incidence is estimated at 50-100 million cases for dengue fever and over 500,000 hospitalizations annually for DHF, with 90% of DHF cases occurring in children less than 15 years of age (World Health Organization 1998; Gubler DJ 1997a). Mortality from DHF averages 5%, with an estimated 24,000 deaths per year (World Health Organization 1998). Classical dengue fever is a disease found almost exclusively in adults whereas DHF is seen primarily in children (Innis BL 1995). Moreover, epidemic DHF occurs with greater frequency in the southeast Asian region compared with the African and Western hemisphere regions, though DHF outbreaks have become more frequent in the Western hemisphere region during the past 30 years (Halstead SB 1990; Gubler DJ 1987; Halstead SB 1994; Gubler DJ 1997b).

Dengue and DHF fever disease syndromes are caused by four antigenically related but distinct virus serotype agents (DEN-1, DEN-2, DEN-3, and DEN-4) of the genus Flavivirus, family Flaviviridae (Innis BL 1995). Transovarial transmission of dengue viruses in Aedes mosquitoes has been demonstrated in the laboratory (Gubler DJ 1987; Innis BL 1995). Aedes aegypti is considered to be the most important epidemic vector of dengue and DHF because it is a highly domesticated mosquito, preferring to live in close proximity to humans (Gubler DJ 1997a; Innis BL 1995). While data suggest that urban-dwelling Aedes aegypti mosquitoes are less efficient vectors for dengue viruses compared with forest and peridomestic Aedes species, it appears that anthropophilic Aedes aegypti is a very efficient vector of epidemic dengue

by feeding on highly viremic humans and infecting naive humans with dengue virus(es) during subsequent bloodmeals (Gubler DJ 1987; Innis BL 1995). In fact, it is strongly suspected that Aedes aegypti may possess the capacity for selecting and propagating epidemic strains of dengue viruses in urban situations (Gubler DJ 1987). This may affect the virulence of the viral agents that cause DHF, which can be fatal (Gubler DJ 1987). Classical dengue fever does not normally result in death (Gubler DJ 1997a; Innis BL 1995). In southeast Asia, it appears that all four dengue virus serotypes cause severe illness in children (adults are rarely affected), with one virus serotype predominating in any given year (Gubler DJ 1997a; Innis BL 1995). However, every 2-3 years the dominant virus serotype changes. It is unclear what host, virus, and vector factors promote the waxing and waning of a virus serotype, although speculation surrounds cohort effects comprised of host immunity, including enhancing antibodies, from past exposure to dengue (Innis BL 1995).

There are two known natural life cycles of dengue viruses. One is an enzootic forest cycle involving non-human primates (i.e., monkeys) and Aedes-complex forest canopy dwelling mosquitoes. The other is an endemic urban/periurban cycle involving humans and domestic, urban dwelling Aedes aegypti mosquitoes. In the forest cycle non-human primates are probably the reservoir for dengue viruses. In the urban/periurban cycle, humans are the primary reservoir (Gubler DJ 1997a; Halstead SB 1994; Innis BL 1995).

Dengue fever is known as 'breakbone fever' due to the severe joint and muscle

pain that is characteristic for this illness (Gubler DJ 1997a; Bancroft TL 1906).

Clinically, dengue fever presents with sudden onset, fever for 3-5 days (but usually not lasting not more than 7 days), intense headache, muscle and joint pain, eye pain, gastrointestinal disturbances, and a rash that is visible in light-skin colored persons (Innis BL 1995). The hemorrhagic form of dengue fever (DHF) is a severe illness, recognized primarily in children, and endemic in much of South and Southeast Asia, the Pacific, and Latin America (Halstead SB 1990; Gubler DJ 1997a; Gubler DJ 1997b). DHF is characterized by abnormal vascular permeability, hypovolemia, and abnormal blood clotting (Benenson AS 1995; Innis BL 1995). DHF can be a fatal disease without supportive treatment to replace fluids lost from plasma leakage (Benenson AS 1995).

Preventive measures against dengue and DHF include education of the public and medical and public health professionals about the benefits of removing larval breeding habitats near living quarters, use of insect repellent on skin, clothes, and in sleeping quarters, wearing long-sleeved clothing and pants if outdoors during the day or evening, and use of mosquito netting over the bed, including permethrin-impregnated netting materials which are particularly effective (Benenson AS 1995; Centers for Disease Control and Prevention 1997d; Binka FN et al. 1996; Quinones ML et al. 2000). Internationally, studies of community-based dengue prevention have been conducted in Puerto Rico (Gubler DJ 1989; Gubler DJ and Clark GG 1994) and Mexico (Lloyd LS et al. 1994; Winch P et al. 1991; Lloyd LS et al. 1992). Using

primarily ethnographic and formative research methods, these studies attempted a “bottom-up” approach (Gubler DJ 1989) wherein the importance of Aedes aegypti larval source reduction was communicated to at-risk communities in the form of pre-tested written, graphic, and radio and television educational media that incorporated local terminology and encouraged local participation and responsibility. “Top down” approaches have traditionally relied on legislative and punitive measures to enforce local compliance with larval source reduction (Gubler DJ 1989; Gubler DJ and Clark GG 1994), methods that have been found to be relatively unsuccessful and unsustainable in reducing Aedes aegypti given increasingly limited government resources available for vector control (Winch P 1998). In both Puerto Rico and Mexico, some success was achieved in the reduction of Aedes aegypti densities, as measured by container-specific Breteau indices, i.e., where the numerator represents the number of each type of container found positive for Aedes aegypti larvae and the denominator represents the number of house lots inspected x 100 (Gubler DJ and Clark GG 1994; Lloyd LS et al. 1992). In the Mexico study, significant changes were demonstrated in community knowledge of larval production sites and in behaviors to remove certain high larval production containers, such as tires, bottles, and jars, as measured at week one and, again, at week 24, following a four-month intensive educational campaign in the community (Lloyd LS et al. 1992). The authors note that a major limitation to this approach to dengue control is “that if participation is not 100%, the mosquito can still breed and dengue viruses may still circulate (page 410)” (Lloyd LS et al. 1994). Thus,

in the context of dengue fever and DHF prevention and to build upon the useful results generated by ethnographic studies above, internationally-focused researchers should consider a health behavior theoretical basis to explore the barriers and motivators to community-participation in larval site reduction. Such efforts might include consideration of the thematic areas common to theories of health behavior beyond levels of knowledge about dengue and Aedes aegypti, to address the perceived severity of the dengue and Aedes aegypti, the perceived susceptibility to dengue (and mosquito bites) for others and for oneself, and the perceived effectiveness of recommended measures to prevent exposure to dengue-infected mosquitoes (Janz NK and Becker MH 1984; Becker MH 1974; Bandura A 1977; Ajzen I and Fishbein M 1980; Connors M and Norman P 1996; Weinstein ND 1988; Weinstein ND 1993; Bandura A 1995; Green LW and Kreuter MW 1991; Weinstein ND and Sandman PM (in press)).

Human bubonic plague

Human bubonic plague is a bacterial illness acquired by the bite from an infected flea that acquires the bacterium Yersina pestis by feeding on rodent reservoirs, such as rats or prairie dogs. In 1994, an outbreak that was possibly plague occurred in India and raised concerns about plague being imported into the United States (Centers for Disease Control and Prevention 1994a). Plague is endemic in the southwest United States (Centers for Disease Control and Prevention 1994b; Fritz CL et al. 1996) and

many countries of the world, notably, parts of Argentina, Central and Southeast Asia, Brazil, China, India, Kenya, Madagascar, Morocco, Mozambique, Saudi Arabia, South Africa, Tanzania, Zaire, and Zimbabwe (Craven RB and Dennis DT 1997). In the U.S. in 1995, nine confirmed cases of plague were reported, all in the southwest, of whom one died (Centers for Disease Control and Prevention 1996c). In 1996, five cases of human plague were reported; two were fatal (Centers for Disease Control and Prevention 1997b). As with RMSF, lack of knowledge about the potentially fatal risk of the illness by persons living, working, or recreating in plague endemic areas, coupled with the potential for misdiagnosis by inexperienced or uninformed medical care providers, may contribute to the observed number of untreated, and subsequently fatal, cases of plague in the U.S. in recent years.

CHAPTER 3

Materials and Methods

Questionnaire

A 55-item survey instrument (Appendix A) was developed with technical consultation provided by Drs. David Dennis, Duane Gubler, and John Roehrig and their staff at the Centers for Disease Control and Prevention (CDC), Division of Vector-Borne Infectious Diseases. The Survey Research Center (SRC) of the University of Maryland at College Park, under the direction of Dr. Stanley Presser and his staff, conducted two ninety-minute, 20-person focus groups to provide qualitative data that served to structure the initial survey instrument (Converse JM and Presser S 1986; Singer E and Presser S 1989). The focus group participants were adults aged 18 years and older from the Washington, DC metropolitan area. Participants were self-selected, having responded to SRC advertisements placed in local newspapers that solicited volunteers to participate in on-going survey research studies carried out by SRC. Informed consent was obtained from each participant who received a stipend of \$20 for their attendance (Presser S, 1998, personal communication). The focus group participants were unaware of the topics to be discussed at either of the focus group sessions. A trained facilitator guided each of the two focus group discussions, starting

with general questions such as “Describe things that bother you” and leading to more specific questions as participants expressed concerns about insects and infectious diseases. When ticks or mosquitoes were brought up by one or more participants, the focus group leader would probe for details on participants’ knowledge and beliefs regarding the illnesses transmitted by ticks and mosquitoes, knowledge and beliefs about severity of these illnesses, the perceived risks of getting diseases transmitted by ticks and mosquitoes in the U.S., and practices the participants employed to prevent being bitten by ticks and mosquitoes (Survey Research Center 1997). The focus-group results revealed that knowledge of ticks, unlike mosquitoes, was not universal among participants. Thus, the questionnaire included a question to ascertain if respondents knew what ticks were.

A preliminary questionnaire was developed based on a review of the focus group audio tapes and notes taken by SRC observers at the focus group sessions (Presser S, 1998, personal communication). This preliminary questionnaire was reviewed and further refined by CDC staff. Pretests were conducted by SRC staff using students at the University of Maryland to assess the readability, sensibility, length, and jump patterns of the preliminary questionnaire (Presser S, 1998, personal communication).

As shown in Appendix C, Table 2, the study variables included in the final questionnaire attempted to address levels of knowledge of and experience regarding mosquitoes, ticks, encephalitis, and Lyme disease; perceived severity of encephalitis

and Lyme disease; the perceived susceptibility of being bitten by mosquitoes or ticks or contracting encephalitis or Lyme disease; the specific practices used to prevent mosquito and tick bites and their frequency; the beliefs about the effectiveness of the specific preventive behaviors (regardless of personal practice); sources of information about encephalitis and Lyme disease; other prevention practices used and captured as open-ended responses; beliefs about likelihood of self or children getting sick from using insect repellent and knowledge of whether the repellent contained the chemical DEET; likelihood for purchasing a vaccine against Lyme disease; and knowledge of and beliefs about whether bubonic plague can be contracted in the U.S. Finally, several sociodemographic variables were also addressed, including newspaper readership and frequency, sources of information, cat and dog ownership, international travel, education level, month/year of birth, Hispanic origin, employment status, race, marital status, household size, residence type, urbanicity of residence, length of residence occupancy, health insurance status of self and household, household income, number of telephone numbers in the residence, and gender.

This was a cross-sectional, computer assisted telephone interview (CATI) survey of adults age 18 or older residing in telephone households in the contiguous U.S. A One-Plus List-assisted random digit dial frame was used (Survey Research Center 1998). An estimated 97 percent of all residential numbers (whether published or not) are included in list assisted random digit dial frames (Brick JM, Waksberg DK, and Starer A 1995). The utility of this approach allows for a successful residential number

contact rate, avoids design effects of clustering, and simplifies administration of the survey (Survey Research Center 1998).

For this study two samples were drawn: a cross-section, designed to yield 1,500 interviews from the 48 states plus the District of Columbia, and an over-sample, designed to yield 250 additional interviews from six states with high incidence of reported cases of Lyme Disease: Connecticut, Delaware, New Jersey, New York, Pennsylvania, and Rhode Island.

The “next birthday” selection method was used to select respondents (Oldendick and et al 1988). With this method the interviewer asks the person who answers the telephone to please let the interviewer speak with the adult in the household who will be the next to celebrate a birthday. This method avoids the potential selection bias of interviewing the household member who is home or routinely answers the phone and, at the beginning of the interview, asking intrusive questions about household composition (Lavrakas P et al. 1993). Respondents were contacted between February 9, 1998 and May 31, 1998. All numbers were called at least 20 times, at different times of day and different days of the week. SRC supervisors monitored questionnaire administration. Respondents who initially refused to participate were re-contacted by a specialist in refusal conversion. About one-third of those re-contacted were successfully interviewed (Survey Research Center 1998). Approximately 15 to 20 minutes were required to conduct the interview.

Analysis

Three design weights were calculated in order for the sample data to be representative of and generalizable to the adult population of the United States. First, every telephone number in the random digit dial frame had an equal probability of selection, thus giving those households with more than one non-business telephone number higher chances of being included in the sample. In order to correct for this potential selection bias, a weight based on the reciprocal of the respondents' answer to a question about the number of non-business telephone lines in their household was created. Second, persons who resided in households with greater than one resident had a lower probability of being a respondent, given only one adult was selected for participation. In order to adjust for this potential bias in respondent selection, a weight based on the number of adults in the household was created. Thirdly, selecting an over-sample in the six Lyme disease endemic states gave households in those states a higher probability for being included in the overall sample. In order to correct for this potential selection bias, a weight based on the different selection probabilities by state was constructed.

For example, a case from a household with four adults aged at least 18 years old was assigned a weight four times as large as a case from a household with only one adult, and by extension, twice as large as a case from a household with two adults. Likewise, a case from a household with four non-business phone lines was assigned a weight one-fourth as large as a case from a household with a single non-business phone

line, and by extension, one-half as large as a case from a household with two non-business phone lines. Thus, a case from a household with three adults and one non-business phone line was initially assigned a weight of 3 (three times one), and a case from a household with 2 adults and 2 phone lines was initially assigned a weight of 1 (two times one-half). Then cases from the over-sampled states were multiplied by a smaller weight than those from the remaining states exactly in proportion to the differences in the chances of selection. Following this, the post-stratification weights were computed in iterative fashion. For instance, if the distribution among the interviews (after the design weights were applied) was 60/40 women/men and the Current Population Survey (CPS) (U.S. Census Bureau 1997b) estimate for the distribution was 52/48, each female case would be down-weighted by the fraction 52/60, and the men up-weighted correspondingly, thereby forcing the weighted sample to be 52/48 women to men. Next, the resulting weighted distribution on age was weighted to the CPS estimate on age. The resulting weighted distribution on education was then weighted to the CPS estimate on education; similarly for race and Census region. Finally, the process was repeated (since weighting on the other variables may have caused the sex distribution to depart from the CPS distribution) as many times as needed until the differences between the sample and CPS distributions did not exceed an arbitrary maximum (on the order of 1 or 2 percentage points). Finally, every weight was multiplied by a constant factor that forced the weighted total to equal the unweighted total number of cases (Presser S, 1998, personal communication).

Post-stratification design weights were developed for the demographic variables of sex, age, education, race, and census region. This corrects the sample distributions on these variables to resemble those of the United States population based on data collected by the U.S. Census Bureau (U.S. Census Bureau 1997b).

The three design weights and the post-stratification weights were merged into an overall weight (WT), which was normed so that it summed to 1,750, the actual number of completed interviews. In order to minimize the variance of the weights, the very small number of cases with weights smaller than 0.2 or larger than 5.0 were excluded, so there were no weights outside that range (Survey Research Center 1998). WT was used for all analyses that combined the cross-sectional and the over-sample.

Analyses that compare respondents in the six Lyme disease states to those in the other 42 states and the District of Columbia (or analyses of only one of the two groups) use a second weight designated LYMEWT. Its construction was similar to WT except that the poststratification was done separately for the two groups. This is true with the exception of education, for which current state level estimates could not be obtained. Thus, the national estimate for education was obtained from the U.S. Census Bureau: Educational Attainment in the United States: March 1996 (Update) (U.S. Census Bureau 1997a). Estimates for the remaining variables came from the U.S. Census Bureau: Estimates of the Population of States by Age, Sex, Race and Hispanic Origin (U.S. Census Bureau 1997b; Survey Research Center 1998).

Standard errors based on simple random sampling assumptions may be

misleading given the design weights calculated above. In other words, the computed variance of estimates from the survey may be less precise when producing an equal probability sample of individuals and adjusting for nonresponse. To assess the impact of this, SRC estimated a design effect for all non-demographic items in the questionnaire. The square root of the design effect multiplied by the standard error (for simple random sampling) yields more exact standard errors (Survey Research Center 1998). The standard errors at the 95% confidence level, based on the average design effect for all the non-demographic variables, are shown in Appendix C, Table 3. The standard error for this survey for the overall sample was 2.9%.

SPSS® for Windows software was used to perform univariate and logistic regression analyses (1999). The chi-square statistic, with Yates correction (Fleiss JL 1981), was used to compare proportions in 2 x 2 and 2 x n tables that considered the full national sample, the national sample stratum that excluded Connecticut, Delaware, New Jersey, New York, Pennsylvania, and Rhode Island, and the stratum that included the over-sampled states of Connecticut, Delaware, New Jersey, New York, Pennsylvania, and Rhode Island.

At the time of the study, each of the over-sampled states was known to have a high prevalence of Lyme disease (Appendix C, Table 1). In late 1999, following data collection for this study, an outbreak of West Nile viral encephalitis (WNV) occurred in the New York City metropolitan area, the first known occurrence of WNV in the Western hemisphere (Centers for Disease Control and Prevention 1999g; Centers for

Disease Control and Prevention 1999c). The WNV epizootic originally affected Connecticut, Maryland, New York, and New Jersey and expanded in 2000 into Delaware, Massachusetts, New Hampshire, North Carolina, Pennsylvania, Rhode Island, Vermont, Virginia and the District of Columbia (Centers for Disease Control and Prevention 2000g; Centers for Disease Control and Prevention 2000d; Centers for Disease Control and Prevention 2000b; Centers for Disease Control and Prevention 2000e; Centers for Disease Control and Prevention 2000f; Centers for Disease Control and Prevention 2001a). All six of the Lyme disease states over-sampled for this study were also affected by the WNV outbreak: Connecticut, Delaware, New Jersey, New York, Pennsylvania, and Rhode Island. Thus, the over-sample data set (in addition to the national data set) was also used to analyze those variables pertaining to mosquitoes and arboviral encephalitis. As a result, this analysis provides a unique baseline of knowledge, attitudes, and practices regarding mosquitoes and arboviral encephalitis in Connecticut, Delaware, New Jersey, New York, Pennsylvania, and Rhode Island prior to the 1999 WNV outbreak in this six state area.

The chi-square test of independence was used to detect univariate relationships among the groups. For screening purposes, based on recommendations by Hosmer and Lemeshow, the level of significance for the univariate analyses was set at $p < 0.25$ (Hosmer DW and Lemeshow S 1989). Self-reported behavior to prevent tick bites was the outcome variable of interest, and several predisposing factors that could influence behavioral action were considered as predictor variables, such as knowledge,

attitudes, beliefs, values, perceived risk, and sociodemographic and lifestyle characteristics.

Selected independent variables representing knowledge, perceived severity, perceived susceptibility, beliefs in effectiveness of precautions, and sociodemographic variables (Appendix C, Table 2) that were shown to be individually statistically significantly ($p < 0.25$) associated with the dependent variable of self-reported preventive behavior in the univariate analyses were the evaluated using logistic regression in order to test the hypotheses that these independent variables were predictive of specific self-reported preventive behaviors. The analyses were done separately for mosquitoes and ticks.

Further, an index measure was developed to represent the combination and frequency of performing specific behaviors an individual might use to prevent mosquito or tick bites. Those respondents who indicated they had done something to prevent mosquito or tick bites were asked whether and how often they performed the specific behaviors (Appendix C, Table 2).

The index measure for the prevention of tick bites was created by summing the positive responses (coded 0 for no and 1 for yes) to any of the following seven behavior variables: 1) repellent use to prevent bites; 2) repellent use on skin; 3) repellent use on clothes; 4) wearing long sleeves and long pants; 5) tucking socks into pants or boots; 6) staying away from woods or grassy areas; and 7) doing anything else to prevent tick bites. This value was then added to the sum of positive responses for

the individual who responded as having performed behaviors 2 through 6 above “occasionally” (coded 0) or “sometimes or often” (coded 1). The tally of these seven behavior variables plus the five frequency of action variables yielded an individual action score ranging from 0 for performing none of the behaviors to 12 for performing all the behaviors “sometimes or often.” The index measure was then dichotomized and coded 0 = “no action,” for individual summary scores equaling zero, and coded 1 = “action,” for individual summary scores greater than or equal to 1 because either the individual did or did not perform the behavior.

Similarly, an index measure for the prevention of mosquito bites was created by summing the positive responses (coded 0 for no and 1 for yes) to any of the following six behavior variables specific to mosquito bite prevention: 1) repellent use; 2) repellent use on skin; 3) repellent use on clothes; 4) staying indoors late afternoon and evenings; 5) wearing long sleeves and long pants; and 6) doing anything else to prevent mosquito bites. This value was then added to the sum of positive responses for the individual who responded as having performed behaviors 2 through 5 above “occasionally” (coded 0) or “sometimes or often” (coded 1). Thus, when tallied for each respondent, the six behavioral variables and the four frequency of action variables yielded a mosquito bite prevention index score ranging from 0 for performing none of the behaviors to 10 for performing all the behaviors “sometimes or often.” The index measure was then dichotomized and coded 0 for “no action,” for individual summary scores equaling zero, and coded 1 for “action,” for individual summary scores greater

than or equal to 1 because either the individual did or did not perform the behavior.

Regarding intentions to vaccinate, a question was asked about the respondent's willingness to pay for a vaccine to prevent Lyme disease, if one was available.^e

Respondents had an equal probability of being asked one of two costs (\$50 and \$100) and one of two effectiveness percentages (50% and 75%). These values were selected based on estimates of the probable range of costs and seroconversion rates current at the time of the study.^f As such, respondents were asked "Suppose there was a safe and effective vaccine, which, if taken every year, would protect against Lyme disease. If the vaccine to prevent Lyme disease cost you [A] [B], which was not covered by a health plan, would you get it?" where A = \$50 and B = \$100. Respondents' willingness to pay for the vaccine was further conditioned on a theoretical level of effectiveness: "Would you pay for it if it were only [A] [B] percent effective?" where A = 50% and B = 75%. Thus the $H_0: AB$ [in positions 1 and 2] = AB [in positions 2 and 1] was tested using 2 x 2 contingency tables and the chi-square statistic.

Analyses of this data set considered the national sample, the national sample stratum that excluded Connecticut, Delaware, New Jersey, New York, Pennsylvania, and Rhode Island, and the stratum that is comprised of only the six high incidence Lyme disease states of Connecticut, Delaware, New Jersey, New York, Pennsylvania, and

^e No commercial vaccine to prevent Lyme disease in humans was available at the time of this survey.

^fDr. David Dennis, Chief, Bacterial Zoonoses Branch, CDC, personal communication, 1997.

Rhode Island. Odds ratios (OR) and 95% confidence intervals (CI) were calculated. All analyses were performed using design weights, as described above.

National Sample

For the national cross-sectional sample, interviewers dialed 4,200 random telephone numbers and successfully interviewed 1,489 eligible persons aged 18 years or older living in private residences. The disposition of the 4,200 telephone numbers in the cross-sectional sample is shown in Appendix C, Table 4a. Of the 4,200 numbers, 1,437 were non-households (businesses, other non-households, and non-working numbers). In addition, 297 numbers were never answered after at least 20 call-backs and were assumed to be non-households. Of the 2,466 identified households, 504 were refusals, 332 were non-contacts (either a respondent was never selected, for example, because the phone was always answered by a household answering machine, or the selected person was never reached for an interview), and 141 households had difficulties such as a non-English speaker, an illness, or hearing problems. A total of 1,489 households were interviewed yielding a 60% cross-sectional response rate (completed interviews divided by eligibles).

Over-sample: Lyme Disease States

For the Lyme disease high incidence states over-sample, interviewers made 800 random telephone calls and successfully interviewed 261 eligible persons aged 18 years or older living in private residences. The disposition of the 800 telephone numbers in the over-sample is shown in Appendix C, Table 4b. Of the 800 numbers,

246 were non-households (businesses, other non-households, and non-working numbers). In addition, 55 numbers were never answered after at least 20 call-backs and are assumed to be non-households. Of the 499 identified households, 107 were refusals, 102 were non-contacts (either a respondent was never selected, for example, because the phone was always answered by a household answering machine, or the selected person was never reached for an interview), and 29 households had difficulties such as a non-English speaker, an illness, or hearing problems. A total of 261 households were interviewed yielding a 52% over-sample response rate (completed interviews divided by eligibles).

The overall sample of 1,750 eligible persons consisted of an almost equal number of men (47%) and women (53%), a greater proportion of married persons (60.7%), and was predominately White (84.1%). About half of the sample was employed full-time (54.5%) and reported having completed high school (51.1%). Almost three-fourths lived in single family homes (71.7%) with an average length of occupancy of 11.8 years. The majority of respondents reported having an annual household income of \$50,000 or less (54.8%). The average age of respondents was 45 years. Almost nine of 10 respondents indicated their families had health insurance coverage (86%). As shown in Appendix C, Table 5, when comparing the national sample (excluding the six high incidence Lyme disease states) with the six high incidence Lyme disease states group on sociodemographic variables, statistically significant differences were observed on the following variables: reads newspaper regularly

($p=0.108$), pet ownership ($p=0.0001$), employment status ($p=0.008$), reason for unemployment ($p=0.021$), type of home ($p=0.001$), location where respondent lives ($p=0.0001$), years at current residence ($p=0.0001$), insurance coverage ($p=0.038$), and household income ($p=0.121$).

Publishable Manuscripts

The following two chapters present the results and a discussion of the above analyses in the form of publishable manuscripts for submission to a peer-reviewed public health journal, such as the American Journal of Public Health, the American Journal of Preventive Medicine, or the Journal of Health Behavior and Education. Chapter 4 presents an analysis of the tick and Lyme disease data, and Chapter 5 addresses the mosquito and encephalitis data.

CHAPTER 4

Publishable manuscript #1 (~ 6500 words; 4 tables/figures)

Risk Perceptions of Ticks and Lyme Disease

Introduction

Lyme disease is caused by the tick-borne bacterium Borrelia burgdorferi and accounts for more than 90% of all reported cases of vector-borne illness in the United States (Dennis DT 1998; Centers for Disease Control and Prevention 2002). Lyme disease was first described in the United States in 1977 as a chronic arthritis among children living in Old Lyme, Connecticut (Steere AC et al. 1977). A national standardized case definition was implemented nationwide in 1991 by the Council of State and Territorial Epidemiologists (Wharton M et al. 1990). The number of reported cases of Lyme disease increased from 9,470 in 1991 to 17,730 in 2000, with more than 132,000 cumulative cases reported during this period (Centers for Disease Control and Prevention 2002). Not surprisingly, the number of popular press articles on Lyme disease has increased steadily between 1982 and 2001 (Figure 1) (Lexis-Nexis Academic Universe 2002). Lyme disease has been reported by 49 states, the District of Columbia, and Guam (Centers for Disease Control and Prevention 1997c). In 2000, the mean annual incidence was 6.3 reported cases per 100,000 persons

(Centers for Disease Control and Prevention 2002). The biology, ecology, and epidemiology of Lyme disease are well documented (Steere AC et al. 1977; Burgdorfer WA et al. 1982; Steere AC et al. 1993; Dennis DT 1998; Rahn DW and Evans J 1998; Barbour AG 1996; Pfister HW, Wilske B, and Weber K 1994; Falco RC and Fish D 1988; Kalish R 1993; Schulze TL, Jordan RA, and Hung RW 1995; Schulze TL et al. 1994).

In the year of the current study, 1998, over 90% of Lyme disease cases were reported by 10 states (Table 1) (Centers for Disease Control and Prevention 2000c). However, a total of 6,752 cases (7.6%) in 1998 were reported from 39 states with low or no known Lyme disease risk (Centers for Disease Control and Prevention 2000c). Ticks are also vectors for other infectious and potentially fatal illnesses in the U.S., including human granulocytic ehrlichiosis, babesiosis, and Rocky Mountain spotted fever (Centers for Disease Control and Prevention 1996b; Centers for Disease Control and Prevention 1995c; Fishbein DB, Dawson JE, and Robinson LE 1994; Centers for Disease Control and Prevention 1989; Lederberg J 1997; Varde S, Beckley J, and Schwartz I 1998; Abramson JS and Givner LB 1999; Paddock CD et al. 1999; Eng TR, Harkess JR, and Fishbein DB 1990). However, studies on the prevalence of behavioral risk factors for tick-bite and Lyme disease prevention are relatively few (Hallman W et al. 1995; Herrington JE 2002; Brown SW et al. 1992; Cartter ML et al. 1989; Shadick NA et al. 1997; Schwartz BS and Goldstein MD 1990). Thus, the purpose of this study was to establish a nationally representative baseline on

knowledge, attitudes, and practices regarding ticks and tick-borne Lyme disease. Specifically, this study identified and examined potential factors that could influence and motivate individuals to adopt measures to prevent personal infection from agents transmitted by ticks, specifically the spirochete Borrelia burgdorferi that causes Lyme disease.

Methods and Materials

The Survey Research Center, University of Maryland at College Park, in collaboration with the U.S. Centers for Disease Control and Prevention (CDC), developed and administered a national survey on vector-borne infectious diseases (Survey Research Center 1998). Based on focus-group research and extensive pretesting (Herrington JE 2002) a 55-item questionnaire was administered using a computer assisted telephone interview system. A list-assisted random digit dial frame was used (Survey Research Center 1998). For this study two samples were drawn: a cross-section, designed to yield 1,500 interviews from the 48 contiguous states plus the District of Columbia, and an over-sample, designed to yield 250 additional interviews from six states with high incidence of reported cases of Lyme Disease: Connecticut, Delaware, Rhode Island, New Jersey, New York, and Pennsylvania. The “next birthday” selection method was used to select respondents (Oldendick and et al 1988). The standard error for the overall sample was 2.9%.

Post-stratification design weights were developed for the demographic variables of sex, age, education, race, and census region. This corrects the sample

distributions on these variables to resemble those of the United States population based on data collected by the U.S. Census Bureau (U.S. Census Bureau 1997b; U.S. Census Bureau 1997a). An overall weight was used for all analyses that combine the cross-sectional and the over-sample. Analyses that compared respondents in the six Lyme disease states to those in the other 42 states and the District of Columbia (or analyses of only one of the two groups) used a second weight.

For the U.S. cross-sectional sample, interviewers dialed 4,200 random telephone numbers and successfully interviewed 1,489 eligible persons aged 18 years or older living in private residences, yielding a 60% cross-sectional response rate (completed interviews divided by eligibles). For the Lyme disease high incidence states over-sample, interviewers made 800 random telephone calls and successfully interviewed 261 eligible persons aged 18 years or older living in private residences yielding a 52% over-sample response rate (completed interviews divided by eligibles). SPSS® software was used to perform univariate and logistic regression analyses (1999). The chi-square statistic, with Yates correction (Fleiss JL 1981), was used to compare proportions in 2 x 2 and 2 x n tables that considered the full U.S. sample, the U.S. sample excluding Connecticut, Delaware, New Jersey, New York, Pennsylvania, and Rhode Island (non-LD states), and the stratum that included the over-sampled states of Connecticut, Delaware, New Jersey, New York, Pennsylvania, and Rhode Island (LD states).

The variables of interest addressed by this study reflect the thematic areas

common to theories of health behavior, namely, levels of knowledge about a given hazard, the perceived severity of the hazard, the perceived susceptibility to the hazard for others and for oneself, and the perceived effectiveness of recommended measures to prevent exposure to the hazard (Janz NK and Becker MH 1984; Becker MH 1974; Bandura A 1977; Ajzen I and Fishbein M 1980; Connors M and Norman P 1996; Weinstein ND 1988; Weinstein ND 1993; Bandura A 1995; Green LW and Kreuter MW 1991; Weinstein ND and Sandman PM (in press)). For the present study, data were collected on the following variables: levels of knowledge and experience regarding ticks and Lyme disease; perceived severity of Lyme disease; the perceived susceptibility of being bitten by ticks or getting Lyme disease; the specific practices used to prevent tick bites and the frequency of these practices; the beliefs about the effectiveness of the specific behaviors (regardless of personal practice) to prevent tick bites; the sources of information about Lyme disease; the other prevention practices used (open-ended responses); the beliefs about the likelihood of oneself or one's children getting sick from using insect repellent; the knowledge of whether the repellent used contained the chemical DEET; and the perceived likelihood for purchasing a vaccine against Lyme disease. Several sociodemographic variables were also addressed, including newspaper readership and frequency, sources of news information, cat and dog ownership, international travel, education level, age, Hispanic origin, employment status, race, marital status, household size, residence type, urbanicity of residence, length of residence occupancy, health insurance status of

respondent and respondent's household, household income, number of telephone numbers in the residence, and gender.

Based on the results of univariate analyses, independent variables were screened and those that demonstrated statistically significant ($p < 0.25$) (Homser DW and Lemeshow S 1989) associations with self-reported behavior to prevent tick bites were entered into a logistic regression program (1999). The independent variables were coded 0 for no and 1 for yes for the following: knowledge: having seen ticks the previous summer; having heard about Lyme disease; perceived severity for others: knowing someone who has had Lyme disease; knowing how someone gets Lyme disease; belief that Lyme disease is a very serious illness; perceived susceptibility for self: being very concerned about being bitten by ticks; a high likelihood of ever getting Lyme disease; perceived effectiveness of precautions available: stayed away from woods; used insect repellent; wore long sleeves and long pants; tucked pants into socks or boots; and knew that the insect repellent used contained DEET. Several sociodemographic variables that were shown by the univariate analyses to be statistically significant were also entered into the logistic regression equation.

Logistic regression analyses were performed in order to ascertain, within a 95% level of confidence and to control for confounding factors, which of the above independent variables would be predictive of respondents' self-reported tick-bite prevention practices, namely, to use insect repellent to prevent tick bites; to use insect repellent on one's skin; to use insect repellent on one's clothes; to wear long sleeves

and long pants; to tuck socks into pants or boots; to stay away from woods or grass; and, to indicate having done anything else to avoid ticks. All variables identified during the univariate screening process as being statistically significant ($p < 0.25$) and behaviorally plausible were entered into the logistic regression equation simultaneously (Menard S 1995).

An index measure was developed to represent the combination and frequency of performing specific behaviors an individual could use to prevent tick bites. Those respondents who indicated they had done something to prevent tick bites were asked whether and how often they performed the specific behaviors. The index measure for the prevention of tick bites was created by summing the positive responses (coded 0 for no and 1 for yes) to any of the following seven behavior variables: 1) used repellent to prevent tick bites; 2) used repellent on skin; 3) used repellent on clothes; 4) wore long sleeves and long pants; 5) tucked socks into pants or boots; 6) stayed away from woods or grassy areas; and 7) did anything else to prevent tick bites. This value was then added to the sum of the positive responses for the individual who indicated as having performed behaviors 2 through 6 above “occasionally” (coded 0) or “sometimes or often” (coded 1). The tally of the behavioral variables plus the frequency of action variables yielded an individual action score ranging from 0, for performing none of the behaviors, to 12, for performing all the behaviors with more than occasional frequency. The index measure was then dichotomized and coded 0 for “no action,” for individual summary scores equaling zero, and coded 1 for “action,” for individual summary scores

greater than or equal to 1. Although power may be lost with binary data, tick bite preventive behaviors are either performed or not performed, similar to seat belt use but unlike some chronic illnesses, such as arteriosclerosis, which can result from certain dietary or smoking behaviors that over time may have cumulative and deleterious effects on an individual's health. Thus, it would be biologically reasonable to use continuous or categorical measures in the latter case, but not necessarily so with the tick bite prevention index.

Sample description

The overall study sample of 1,750 eligible persons consisted of an almost equal number of men (47%) and women (53%), a greater proportion of married persons (60.7%), and was predominately White (84.1%). About half of the sample was employed full-time (54.5%) and reported having completed high school (51.1%). Almost three-fourths lived in single family homes (71.7%) with an average length of occupancy of 11.8 years. The majority of respondents reported having an annual household income of \$50,000 or less (54.8%). The average age of respondents was 45 years. Almost nine of 10 respondents indicated their families had health insurance coverage (86%). When comparing the non-LD states group with the LD states group on sociodemographic variables, statistically significant differences were observed for the following: reads newspaper regularly ($p=0.108$), pet ownership ($p=0.0001$), employment status ($p=0.008$), reason for unemployment ($p=0.021$), type of home ($p=0.001$), location where respondent lives ($p=0.0001$), years at current residence

($p=0.0001$), insurance coverage ($p=0.038$), and household income ($p=0.121$) (data not shown).

Results

Baseline data from the U.S. sample ($n=1750$) revealed that 96% of respondents knew what ticks were, of whom 47% had seen ticks the previous summer, mostly in the respondent's state. Forty percent reported they did anything to avoid being bitten by ticks. Less than half (41%) of the 455 respondents who stated they did something to avoid being bitten reported using an insect repellent. Of those who used insect repellent, the vast majority reported using it on their skin (77%) and on their clothes (74%) (Table 2).

Slightly more than half of the respondents who stated that they did anything to avoid being bitten by ticks said they wore long sleeves and long pants (57%), stayed away from woods or grassy areas (51%), tucked their socks into pants or boots (41%), or did anything else to avoid ticks (30%) (Table 2). Of the open-ended responses of having done anything else to avoid tick bites, a hand tally revealed that the most frequently cited behaviors were checking one's body for ticks (25%), spraying/treating the yard with insecticides/acaricides (20%), checking/treating pets for ticks (9.5%), wearing a hat (8%), and being aware of ticks (3%) (data not shown).

All respondents, regardless of personal practice, were asked their perceptions about the effectiveness of specific tick-bite prevention methods. Nearly nine-tenths (88%) of respondents stated that staying away from woods or grassy areas was

somewhat to very effective, almost four-fifths (79%) said tucking socks into pants or boots was somewhat to very effective, over two-thirds (70%) indicated that wearing long sleeves and long pants was somewhat to very effective, while almost three-fifths (58%) said that using an insect repellent was somewhat to very effective in preventing tick bites (Table 2).

All 1750 respondents were also asked if they thought using an insect repellent could make oneself sick. Respondents were almost evenly split on this question with slightly more than half (51%) believing it unlikely that insect repellent could make oneself sick while less than half (42%) stated this was somewhat to very likely. Seven percent of respondents stated they did not know. By contrast, the opposite appeared to be the case among the 600 respondents who said they had children, with slightly more than half (53%) stating it was somewhat to very likely that insect repellent could make their children sick and less than half (41%) indicating that this was unlikely. Six percent said they did not know. The active chemical ingredient found in many over-the-counter insect repellents intended for use on human skin to prevent tick bites is *N,N*-diethyl-*m*-toluamide, commonly known as DEET. Concentrations of DEET vary between 8% to 100% among products available to the public. After over 40 years of worldwide use, DEET has an exceptional safety record (Fradin MS 1998). However, toxic reactions have been reported when the product is not used according to the manufacturer's labeled instructions (Fradin MS 1998; Garrettson LK 1997). Of the 788 respondents who were asked if the repellent they used contained DEET, about

two-thirds (65%) did not know. Less than one-fifth of respondents were certain that their insect repellent did (16%) or did not (19%) contain DEET.

A total of 1507 (86%) respondents in the U.S. sample had heard of Lyme disease. Their primary source of information was television (37%), newspapers or magazines (34%), their doctors (7%), radio (2%), or from somewhere else (19%), including friends, family members, co-workers, books, or personal experience. Of the 1507 respondents who had heard about Lyme disease, 1160 (77%) stated that they knew how the illness was caused and 341 (23%) said they had known someone with the illness (Table 2). Based on a hand tally, 97% indicated, in their open-ended response to the question "Please specify how someone gets Lyme disease," that "ticks" were the cause.

Regarding the perceived severity of Lyme disease, slightly more than half (53%) of the respondents reported they were somewhat to very concerned about being bitten by ticks. Almost three-fourths (74%) of the respondents said that Lyme disease was a very or extremely serious illness. Of the 600 respondents with children, 88% felt it was a very to extremely serious illness for children (Table 2).

Regarding perceptions of susceptibility to the illness, respondents were asked to estimate their likelihood of ever getting Lyme disease, using a continuous scale of 0 (never) to 100 (definitely). Of the 1507 respondents from the U.S. sample who had heard about Lyme disease, 1440 (92%) stated their likelihood of ever getting Lyme disease was 50 or less on the 100 point scale (\bar{x} = 29; SD=23.5). Of the 600

respondents with children, 83% stated the likelihood of their children ever getting Lyme disease was 50 or less on the 100 point scale (\bar{x} =34; SD=24.9) (Table 2).

Respondents were asked about specific methods for removing ticks, given anecdotal evidence that inappropriate methods were frequently used, such as touching a hot match head to an embedded tick to make it “back out” (Rahn DW and Evans J 1998). Such caustic methods may result in an infected and engorged tick injecting B. burgdorferi into the person’s skin (Barbour AG 1996). Respondents were asked “If you found a tick attached to yourself, would you use tweezers to remove it or use a hot match, or would you do something else?” To reduce potential response bias due to the ordering of the removal methods in the question, each respondent had an equal probability of “tweezers” or “hot match” being asked in the first position. Data analysis revealed no significant difference in the ordering of first method offered ($X^2 = 5.71, 3$ df, $p=0.13$). “Tweezers” was selected by 38% of respondents when offered in the first position and by 42% of respondents when it was offered in the second position. Whereas, “hot match” was chosen by 23% of respondents when it was offered first and by 17% of respondents when it was offered second (Table 2). The “something else” option was selected by 29% of respondents when “tweezers” was in the first position and by 33% of respondents when “hot match” was in the first position. The “something else” open-ended responses included putting alcohol, nail polish remover, oil, or similar products on the embedded tick (35%), pulling the tick out with one’s fingers (32%), or seeking medical care at a doctor’s office, hospital, or emergency

room (11%) (data not shown). The use of fine-tipped tweezers is the recommended method for removing embedded ticks (Barbour AG 1996).

Those respondents who had heard about Lyme disease were asked whether they would pay for a Lyme disease vaccine at two levels of cost (\$50 and \$100) and at two levels of effectiveness (50% and 75%). At the time of this study, no vaccine against Lyme disease was available for humans.^g We hypothesized that price would affect a respondent's willingness to be vaccinated against Lyme disease. In order to create comparative groups, each respondent had an equal probability of being asked one of two vaccine costs, \$50 and \$100, our best estimate of vaccine cost at the time of this study.^h Further, we hypothesized the effectiveness of a vaccine would affect a respondent's willingness to be vaccinated against Lyme disease. Again, in order to create comparative groups, each respondent had an equal probability of be asked one of two effectiveness levels, 50% and 75%, our best estimate as to the protective effect a vaccine against Lyme disease could provide. For clarity, the exact wording of the questions was:

^g In early 1999, a human vaccine, LymeRiX®, made by SmithKline Beecham, was approved by the U.S. Food and Drug Administration and made commercially available. Based on clinical trials the vaccine was reported to be 76% effective after three doses over 12 months (Centers for Disease Control and Prevention 1999d). However, LymeRiX® was withdrawn in early 2002 by the manufacturer citing "low demand, dwindling sales" amid pending litigation by vaccine recipients claiming vaccine-caused arthritis-like conditions (*Newsday*, Feb. 26, 2002; *Hartford Courant*, Feb. 27, 2002).

^h Once available to the public, a three dose series of LymeRiX® cost on average \$300 per patient (Dr. David Dennis, personal communication, 1999).

“Suppose there were a safe and effective vaccine, which -- if taken every year -- would protect against Lyme Disease. If the vaccine to prevent Lyme Disease cost you \$[fill with dollar amount], which was not covered by a health plan, would you get it? Would you pay for it if it were only [fill with percentage]% effective?”

As a result, of those who had heard about Lyme disease and indicated they would get vaccinated, four groups of respondents were delineated: \$50 cost at 50%, \$50 cost at 75% effectiveness, \$100 cost at 50%, or \$100 cost at 75% effectiveness. Among respondents from the U.S. sample who had heard about Lyme disease, there was no significant difference in willingness to pay \$50 or \$100 cost at either of the two levels of vaccine effectiveness [\$50 cost vs \$100 cost: $X^2 = 1.14$, 1 df, $p = 0.29$; \$50 cost if 50% effective vs. 75% effective: $X^2 = 2.66$, 1 df, $p = 0.10$; \$100 cost if 50% effective vs. 75% effective: $X^2 = 0.77$, 1 df, $p = 0.38$]. Similar results were observed for the respondents from the LD states who had heard about Lyme disease, in that there was no significant difference observed between the four comparative groups when considering vaccine cost and levels of vaccine effectiveness [\$50 cost vs \$100 cost: $X^2 = 3.92$, 2 df, $p = 0.14$; \$50 cost if 50% effective vs. 75% effective: $X^2 = 2.01$, 2 df, $p = 0.37$; \$100 cost if 50% effective vs. 75% effective: $X^2 = 0.98$, 2 df, $p = 0.61$] (data not shown).

However, among respondents from the U.S. sample and the non-LD states stratum who had heard about Lyme disease and stated they had done something to prevent tick bites, statistically significant associations were observed regarding willingness to purchase a purchase a Lyme disease vaccine that cost \$50 ($p = 0.014$

and $p = 0.010$, respectively) or cost \$100 ($p = 0.0001$, $p = 0.0001$, respectively) when compared with respondents who reported having not done anything to prevent tick bites. Curiously, a statistically significant association was only observed for LD states respondents who reported taking action to prevent tick bites regarding willingness to purchase a Lyme disease vaccine that cost \$100 ($p = 0.002$) but not for a vaccine that cost \$50 ($p = 0.773$) (Table 2).

Contingency tables -- 2 x 2 and 2 x n -- were used to cross-tabulate the outcome variable of interest "self-reported behavior to prevent tick bites" (coded 0 for no and 1 for yes) and several knowledge, attitude, belief, and sociodemographic factors that could influence this behavior. The chi-square statistic and crude odds ratios with 95% confidence intervals were calculated for the U.S. sample, the non-LD states stratum, and the stratum consisting of the LD states (Table 3). The following factors were found to be statistically significantly associated with the dependent variable for all three population groups: having seen ticks the previous summer, being somewhat to very concerned to be bitten by ticks, believing that using an insect repellent is a somewhat to very effective method for preventing tick bites, believing that wearing long sleeves and long pants is a somewhat to very effective method for preventing tick bites, having heard about Lyme disease, knowing someone who has had Lyme disease, and purchasing a Lyme disease vaccine that could cost \$100. Owning cats was also found to be significantly associated with the outcome variable for all three population groups (Table 3).

Logistic regression

Several factors emerged from the logistic regression analyses that were predictive of respondents' self-reported practices to prevent tick-bites, regarding both specific methods and the tick bite prevention index. In terms of knowledge and experience, respondents who had seen ticks in one's own state and/or elsewhere were more likely to have taken precautions against ticks, as measured by the tick bite prevention index., including being more likely to tuck socks into pants or boots, and being more likely to stay away from woods or grassy areas, when compared with the referent group who had not seen ticks the previous summer. Among respondents from the LD states, only those who had seen ticks the previous summer, when compared with the referent group who had not seen ticks the previous summer, were more likely to say they had done something else to avoid ticks, a finding that approached statistical significance (Table 4).

Regarding perceived harm to others, respondents from the LD states who stated they had known someone who had Lyme disease were more likely to have adopted precautions against ticks, as measured by the tick bite prevention index, were more likely to have used repellent to avoid tick bites, were more likely to have tucked pants into socks or boots, were more likely to have stayed away from woods or grassy areas than respondents who had not known someone who had Lyme disease.

However, respondents from the non-LD states who had known someone with Lyme disease, were less likely to wear long sleeves and long pants, when compared with the

referent group of respondents who had not known someone who had Lyme disease. Further, respondents from the LD states group who knew how someone gets Lyme disease were more likely to take precautions against tick bites, as measured by the tick prevention index, and were more likely to wear long sleeves and long pants, when compared with the referent group that did not know how someone gets Lyme disease. By contrast, respondents from the U.S. sample and non-LD states who knew how someone gets Lyme disease were less likely to tuck pants into socks or boots, when compared with the referent group of respondents who did not know how someone gets Lyme disease (Table 4).

Respondents from the U.S. sample who believed that Lyme disease was a very to extremely serious illness were more likely to tuck pants into socks or boots when compared with the referent group of respondents who believed that Lyme disease was not too serious or not at all a serious illness. Respondents from the non-LD states who believed that Lyme disease was a very to extremely serious illness were more likely to take precautions against tick bites, as measured by the tick bite prevention index variable, were more likely to wear long sleeves and long pants, and were more likely to tuck pants into socks or boots, when compared with the referent group of respondents who believed that Lyme disease was not too serious or not at all a serious illness. However, respondents from the sample of LD states who believed that Lyme disease was a very to extremely serious illness were less likely to adopt precautions, as measured by the tick bite prevention index,, were less likely to use repellent on clothes,

and were less likely to have stated they did anything else to avoid ticks, but were more likely to tuck pants into socks or boots when compared with the referent group (Table 4).

Regarding perceived harm to oneself, respondents from all three sample groups who were somewhat to very concerned to be bitten by ticks were more likely to adopt precautions, as measured by the tick bite prevention index, when compared with respondents who were not too or not at all concerned to be bitten by ticks. Moderate to high concern to be bitten by ticks was a very strong predictor for all seven specific tick prevention behaviors among respondents from both the U.S. group and the non-LD states, as well for respondents from the LD states group (except on the following variables which were not statistically significant of the LD states: using insect repellent to avoid bites and using insect repellent on clothes), when compared with respondents who were not too or not at all concerned with being bitten by ticks (Table 4).

Further, respondents in the U.S. sample and in the non-LD states who believed their likelihood of ever getting Lyme disease was equal to or greater than 51 (on a scale where 0 = never and 100 = definitely) were more likely to use repellent to avoid tick bites and more likely to use repellent on clothes, when compared with the referent group of respondents who believed their likelihood of ever getting Lyme disease was less than 50 on the 100 point scale. Risk perception regarding the likelihood of ever getting Lyme disease was not a statistically significant predictor for the sample of respondents from the LD states group (Table 4).

Regarding perceived effectiveness of the precautions available, respondents from the U.S. sample who believed that staying away from woods and grassy areas was a somewhat to very effective method were less likely to use repellent on their skin when compared with the referent group of respondents who believed that staying away from woods and grassy areas was not too or not at all an effective method for preventing tick bites. The belief in the effectiveness of this method was not a statistically significant predictor for neither the non-LD states group nor the sample of LD states group of respondents (Table 4).

Respondents from all three groups who believed that using insect repellent was a somewhat to very effective method to prevent tick bites were more likely to use insect repellent, to use insect repellent on their skin, and to use insect repellent on their clothes. By contrast, respondents from the U.S. sample and the non-LD states who believed using insect repellent was somewhat to very effective were less likely to wear long sleeves and long pants when compared with the referent group of respondents who believed that using insect repellent was not too or not at all an effective method for preventing tick bites.

Respondents from the U.S. sample and those from the non-LD states group who believed that wearing long sleeves and long pants was a somewhat to very effective method of preventing tick bites were more likely to wear long sleeves and long pants, tuck pants into socks or boots, and stay away from woods and grassy areas, when compared with the referent group of respondents who believed that wearing long

sleeves and long pants was not too or not at all an effective method for preventing tick bites. Regarding this same variable, respondents from the LD states were less likely to say they did anything else to prevent tick bites if they believed that wearing long sleeves and long pants was a somewhat to very effective method for preventing tick bites, when compared with the referent group who stated this was not too or not at all an effective method (Table 4).

Respondents from the U.S. sample who stated that the insect repellent they used contained DEET were more likely to use insect repellent on their clothes, when compared with the referent group of respondents who stated it did not or were uncertain. Similarly, among the non-LD states group, respondents were more likely to adopt precautions, as measured by the tick bite prevention index, if they said their insect repellent contained the chemical DEET when compared with respondents who said it did not or were uncertain. Although not statistically significant at the 95% confidence level, respondents in the non-LD states were more likely to use insect repellent on their skin and clothes when compared with the referent group who were uncertain or stated it did not contain DEET. Among respondents from the LD states sample, those who stated that the insect repellent they used contained the chemical DEET were more likely to use insect repellent on their clothes, and state they did anything else to prevent tick bites, but were less likely to wear long sleeves and long pants and less likely to stay away from woods or grassy areas, when compared with the referent group of those who were uncertain or stated they did not know if the insect

repellent they used contained DEET (Table 4).

Considering the sociodemographic and lifestyle variables included in the logistic regression, results suggest that some but not all of these variables were predictive of taking precautions against tick bites. At the U.S. level, respondents who reported they read a newspaper regularly were more likely to wear long sleeves and long pants and more likely to stay away from woods or grassy areas, when compared with the referent group of persons who reported not reading a newspaper regularly. For the non-LD states, respondents who reported reading a newspaper regularly were more likely to adopt precautions against tick bite, as measured by the tick bite prevention index, and more likely to wear long sleeves and long pants, when compared with the referent group of persons who reported not reading a newspaper regularly. Among respondents from the LD states, those who reported reading a newspaper regularly were less likely to report having done anything else to prevent tick bites, when compared with the referent group (Table 4).

Pet ownership also appeared to be predictive of taking precautions against tick bites. At the U.S. level, respondents who reported they owned dogs and/or cats were more likely to adopt precautions against tick bites, as measured by the tick bite prevention index, more likely to use insect repellent, and more likely to tuck pants into socks or boots, when compared with the referent group of persons who reported owning no pets. Among respondents of the non-LD states, those who reported owning dogs and/or cats were more likely to adopt precautions against tick bites, as measured

by the tick bite prevention index, and more likely to use insect repellent, when compared with the referent group of persons who reported owning no pets. Respondents from the LD states who reported owning dogs and/or cats were more likely to tuck pants into socks or boots when compared with the referent group of those persons who did not report owning any pets (Table 4).

Respondents at the U.S. level and the non-LD states who reported being married were less likely to adopt precautions against tick bites, as measured by the tick bite prevention index, , when compared with respondents who reported not being married. Moreover, respondents from the non-LD states who reported being married were also less likely to wear long sleeves and long pants when compared to respondents who reported not being married. Marital status was not a statistically significant predictor of tick bite preventive behavior among respondents from the LD states group (Table 4).

Type of home reported by respondents was not a statistically significant predictor of tick bite preventive behavior in any group, except among respondents at the U.S. level who indicated they lived in a single family home. These respondents were less likely to tuck pants into socks or boots, when compared with the referent group of respondents who reported living in an apartment/condominium, row or town house, or duplex (Table 4).

Respondents at the U.S. level who reported living in a city or suburb were less likely to stay away from woods or grassy areas but more likely to report having done

anything else to prevent tick bites, when compared with the referent group of respondents who reported living in a small town or rural area (Table 4). Among the non-LD states group, respondents who reported living in a city or suburb were more likely to use repellent on their skin, tuck pants into socks or boots, and state they did anything else to prevent tick bites, when compared with the referent group of persons who reported living in a small town or rural area (Table 4). Race was not a statistically significant predictor of any tick bite preventive behaviors for any of the three samples considered.

Discussion and Conclusions

In the context of the thematic areas of health behavior theories described above, the results from this survey suggest that certain knowledge, attitudes, beliefs, and perceptions regarding the prevention of tick bites, and the potential for exposure to the spirochete B. burgdorferi that causes Lyme disease, are reasonable predictors and antecedents to the acknowledgment of personal susceptibility and subsequent decisions to act to prevent tick bites. Specifically regarding knowledge and experience, having seen ticks the previous summer, being somewhat to very concerned about being bitten by ticks, believing that using an insect repellent is an effective method for preventing tick bites, having heard about Lyme disease, and knowing someone who has had Lyme disease are the factors observed in this study that best predict specific preventive measures to avoid tick-bites. These findings are consistent with previous state-based studies (Herrington JE et al. 1997).

From a behavioral epidemiological perspective, it is important to understand what are the factors that best predict whether a person decides to and actually takes preventive measures against tick bites. Knowing which factors predispose and influence an individual's taking one or more preventive measures to avoid tick bites can enable public health prevention programs to be more effective in designing targeted educational and behavioral interventions.

Perceptions regarding harm from the hazard to oneself, as illustrated by the variable regarding concern about being bitten by ticks, appears to be the most robust predictor of behavioral action to prevent tick bites for all three sample groups. The statistically significant association between being concerned about being bitten and taking preventive action remained even when the LD states group was excluded from the logistic regression analysis. Thus, the six Lyme disease states group was not a confounding factor in the analysis at the U.S. level regarding concern about being bitten by ticks.

However, other statistically significant antecedent variables appeared to be related exclusively to the LD states group, given the observed association disappears from the U.S. sample when controlling for residence in the LD states group. These factors include the knowledge of how someone gets Lyme disease and the belief that staying away from woods or grassy areas is a very effective method for preventing tick bites.

Several variables appear to be significant at the U.S. level when excluding the

six high incidence Lyme disease states group: knowing if the insect repellent used contained the chemical DEET, believing that Lyme disease is a serious illness, and the low perceived likelihood of ever getting Lyme disease. These apparent differences between the U.S. group and LD states group may reflect greater level of experience and information with the hazard in the latter, effectively attenuating any unrealistic perception of risk that the remainder of the U.S. population may perceive due to inexperience with the hazard. We would expect this based on studies that have shown novel hazards elicit unreal perceptions of risks and increased sense of dread (Slovic P 1987; Fischhoff B 1995; Slovic P, Kraus N, and Covello VT 1990). This is validated by the observation that the respondents from the LD states group who selected tweezers as the method for removing an attached tick were nearly three times more likely to indicate they took action to prevent tick bites, when compared with respondents who chose (erroneously) a hot match as the method they would use for removing an attached tick. This was not the case for the U.S. group as a whole nor for the U.S. group when excluding the six high incidence Lyme disease states respondents. We would expect, based on earlier studies (Herrington JE et al. 1997) that these differences are most likely related to the geographic clustering of Lyme disease cases in the Northeastern U.S. and, therefore, the greater experience and exposure respondents in the LD states group have had in knowing what preventive measures are most effective and appropriate when deciding to take preventive measures against the hazard of tick-borne Lyme disease infection.

As would be expected, and confirmed by the present study, it makes intuitive sense that persons who are more likely to use an insect repellent, whether on their skin or clothes, are less likely to wear long sleeves and long pants or avoid woods or grassy areas, actions that appear to be driven by the perception that insect repellent is an effective method for preventing tick bites. Furthermore, the use of insect repellent may allow the user to not feel compelled to wear long sleeves and long pants during the hot summer months when ticks are most active. Moreover, use of an insect repellent permits freedom of movement in woods and grassy areas, thereby reducing avoidance behaviors, much like one would use a raincoat and umbrella to venture outdoors when it is raining.

In the regression analysis, there were 15 independent variables considered across the three sample groups of which 14 (94%) were statistically significant in predicting one or more of the seven behavioral variables. As a summary measure of the seven behavioral variables, the tick bite prevention index measure appeared to be sensitive to 8 of the 14 independent variables (57%) that were statistically significant in predicting one or more of the seven behavioral variables. Those independent variables the tick bite prevention index measure failed to mirror were: the perception of the likelihood of ever getting Lyme disease, the belief that using insect repellent is effective, the belief that wearing long sleeves and long pants is effective, and urbancity of where respondent lives, even though all of these variables were statistically significant predictors for two or more of the seven behavioral variables. Thus, the tick bite

prevention index may be considered only a moderately robust summary measure of the seven dependent variables addressed in this survey.

As with any random-digit-dialed telephone survey, there are acknowledged limitations to this study. Relying on self-reported data with telephone interviewing methods does not allow the interviewer to validate respondents' answers. Social desirability could also result in bias in reporting sociodemographic and lifestyle characteristics. Further, the intrusive nature of telemarketing may deter some respondents from participating, even after being re-contacted by a refusal conversion specialist (Kristal A et al. 1993). Methods for independent validation of these survey results could be explored through the use of qualitative techniques (Webb EJ et al. 1981; Patton MQ 1990; Patton MQ 1980).

Potential selection bias may have been introduced in that only respondents with telephones were interviewed, thus excluding approximately 5% of U.S. households that do not have a telephone in the home (U.S. Department of Commerce 1999), such as those that might be economically disadvantaged and minority populations. This potential bias in selection of respondents for this study may reduce the representativeness and generalizability to the U.S. population.

Table 1 goes here

State	Number (%)	Cases per 100,000 persons
New York	29,172 (32.8)	23.3
Connecticut	15,523 (17.8)	67.9
Pennsylvania	13,020 (14.6)	15.4
New Jersey	10,852 (12.2)	19.9
Wisconsin	3,237 (3.6)	9.5
Rhode Island	3,128 (3.5)	44.8
Maryland	2,758 (3.1)	8.3
Massachusetts	2,118 (2.4)	2.1
Minnesota	1,522 (1.7)	5.0
Delaware	883 (1.0)	18.5

Table 1. Number of reported cases and rates of Lyme disease, 10 states, United States, 1998 (Centers for Disease Control and Prevention 2000c).

Table 2 goes here.

Table 2. Frequencies regarding knowledge, attitudes, and practices regarding ticks and Lyme disease, United States, 1998.			
Variable	Number (%)		
	U.S. (n=1750) ¹	U.S. excluding LD states (n=1247) ²	LD states (n=503) ²
Know what ticks are	1661 (94.9)	1189 (95.3)	467 (92.8)
Saw ticks last summer	782 (47.1)	565 (47.5)	216 (46.3)
In respondent's state	613 (78.5)	504 (89.3)	167 (77.3)
Somewhat to very concerned to be bitten by ticks	599 (52.5)	420 (51.0)	184 (58.2)
Did anything to avoid ticks	455 (39.8)	310 (37.7)	156 (49.4)
Used repellent to avoid bites	186 (41.0)	129 (41.7)	62 (40.0)
Used repellent on skin	143 (76.8)	97 (75.4)	51 (80.7)
Often on skin	56 (38.9)	38 (39.3)	21 (38.4)
Used repellent on clothes	137 (73.5)	95 (73.6)	46 (73.5)
Often on clothes	46 (33.5)	31 (33.1)	14 (31.4)
Wore long sleeves and pants	260 (57.2)	167 (54.1)	106 (68.6)
Often wore long sleeves and pants	140 (53.9)	90 (53.6)	58 (55.1)
Tucked socks into pants or boots	186 (41.0)	113 (36.8)	85 (54.3)
Often tucked socks into pants or boots	97 (52.0)	57 (50.4)	47 (55.3)
Stayed away from woods or grass	234 (51.4)	156 (50.3)	84 (53.7)
Often stayed away from woods or grass	143 (61.1)	91 (58.5)	58 (69.0)
Did anything else to avoid ticks or prevent being bitten	133 (29.6)	96 (31.3)	36 (23.1)
To remove attached tick, would use:			
Tweezers (1 st choice offered)	224 (38.4)	156 (37.2)	70 (44.6)
Hot match	127 (21.8)	97 (23.0)	24 (15.1)
Both	22 (3.8)	17 (4.0)	4 (2.8)
Something else	169 (28.9)	124 (29.5)	41 (26.2)

To remove attached tick, would use:			
Hot match (1 st choice offered)	97 (17.4)	80 (19.8)	11 (7.2)
Tweezers	234 (41.8)	158 (39.2)	85 (53.7)
Both	16 (2.9)	12 (2.9)	5 (3.1)
Something else	184 (33.0)	134 (33.3)	47 (30.0)
Staying away from woods or grass is very effective	1084 (65.3)	767 (64.5)	323 (69.3)
Using insect repellent is very effective	330 (19.9)	223 (18.8)	116 (24.9)
Wearing long pants/sleeves is very effective	495 (29.8)	326 (27.4)	196 (41.9)
Tucking socks into pants or boots is very effective	693 (41.7)	475 (39.9)	233 (49.9)
Insect repellent used contained chemical DEET			
Yes	125 (15.8)	90 (15.6)	38 (19.0)
No	147 (18.6)	107 (18.5)	37 (18.2)
Don't know/Not sure	516 (65.5)	381 (65.9)	126 (62.7)
Has heard about Lyme disease	1507 (86.4)	1058 (85.1)	467 (92.7)
From where have you heard the most?			
TV	561 (37.2)	400 (37.8)	167 (35.7)
Radio	24 (1.6)	17 (1.6)	7 (1.4)
Newspapers	285 (18.9)	196 (18.5)	99 (21.1)
Magazines	223 (14.8)	160 (15.1)	62 (13.2)
Doctors	103 (6.9)	73 (6.9)	30 (6.5)
Somewhere else	295 (19.5)	200 (18.9)	99 (21.3)
Don't know/Remember	17 (1.1)	13 (1.2)	3 (0.7)
Knows someone who has had Lyme disease	341 (22.6)	198 (18.6)	198 (42.3)
Knows how someone gets Lyme disease	1168 (77.4)	819 (77.3)	366 (78.3)
R specified "tick" (open-ended)	1138 (97.4)	na	na
Lyme disease is extremely serious illness	362 (24.0)	255 (24.1)	113 (24.3)

Lyme disease is extremely serious illness for children (asked of respondents with children)	266 (52.3)	186 (53.1)	83 (49.6)
If a safe and effective vaccine to prevent Lyme disease were available, and <u>not</u> covered by your health plan, would you get it: ³			
at \$50 cost			
Yes	224 (34.8)	137 (30.4)	106 (52.2)
No	356 (55.4)	265 (58.9)	85 (41.9)
Don't know	63 (9.8)	48 (10.7)	12 (5.9)
at \$100 cost			
Yes	275 (39.4)	191 (38.4)	87 (42.4)
No	386 (55.3)	282 (56.7)	103 (50.2)
Don't know	37 (5.3)	24 (4.8)	15 (7.3)
at \$50 cost and 50% effectiveness			
Yes	80 (77.7)	48 (75.0)	40 (81.6)
No	15 (14.6)	10 (15.6)	7 (14.3)
Don't know	8 (7.8)	6 (9.4)	2 (4.1)
at \$50 cost and 75% effectiveness			
Yes	84 (69.4)	50 (68.5)	40 (70.2)
No	28 (23.1)	18 (24.7)	12 (21.1)
Don't know	9 (7.4)	5 (6.8)	5 (8.8)
at \$100 cost and 50% effectiveness			
Yes	93 (69.9)	62 (70.5)	34 (72.3)
No	30 (22.6)	20 (22.7)	9 (19.1)
Don't know	10 (7.5)	6 (6.8)	4 (8.5)
at \$100 cost and 75% effectiveness			
Yes	92 (65.7)	68 (66.7)	25 (64.1)
No	38 (27.1)	27 (26.5)	11 (28.2)
Don't know	10 (7.1)	7 (6.9)	3 (7.7)

1. Cases weighted by WT.
2. Cases weighted by LYMEWT.

3. Respondents had an equal probability of being asked one of following combinations of vaccine cost and vaccine effectiveness: \$50 and 50% or 75%; \$100 and 50% or 75%.

Table 3 goes here

Table 3. Crude odds ratios for self-reported behavior to prevent tick bites and selected variables, United States, 1998.

Variable	U.S. (n=1750) ¹		U.S. excluding LD states (n=1247) ²		LD states (n=503) ³	
	N (%)	OR (95% CI) ⁴	N (%)	OR (95% CI)	N (%)	OR (95% CI)
Saw ticks last summer:						
- Yes	394 (86.6)	4.9 (3.6, 6.8)****	272 (88.0)	5.6 (3.8, 8.2)****	127 (81.4)	3.5 (2.1, 5.9)****
- No/Not Sure	61 (13.4)		37 (12.0)		29 (18.6)	
Somewhat to very concerned to be bitten by ticks:						
- Yes	367 (80.7)	8.3 (6.3, 11.1)****	117 (75.0)	4.3 (2.7, 7.0)****	254 (81.9)	9.7 (6.9, 13.7)****
- No	88 (19.3)		39 (25.0)		56 (18.1)	
Staying away from woods is somewhat to very effective:						
- Yes	431 (95.5)	1.7 (1.0, 3.0)**	291 (95.1)	1.5 (0.8, 2.8)*	152 (98.1)	4.5 (1.3, 16.2)*
- No	20 (4.4)		15 (4.9)		3 (1.9)	
Using insect repellent is somewhat to very effective:						
- Yes	328 (80.0)	2.0 (1.5, 2.6)****	217 (78.6)	1.9 (1.3, 2.6)***	125 (84.5)	2.1 (1.1, 3.7)**
- No	82 (20.0)		59 (21.4)		23 (15.5)	
Wearing long sleeves and long pants is somewhat to very effective:						
- Yes	378 (83.6)	2.0 (1.4, 2.6)****	250 (81.7)	1.8 (1.3, 2.6)***	142 (91.6)	2.4 (1.2, 4.8)**
- No	74 (16.4)		56 (18.3)		13 (8.4)	
Tucking socks into pants or boots is somewhat to very effective:						
- Yes	389 (86.4)	1.4 (1.0, 1.9)*	259 (84.9)	1.3 (0.9, 1.9)	144 (92.9)	1.9 (0.9, 4.1)*
- No	61 (13.6)		46 (15.1)		11 (7.1)	
Insect repellent used contained chemical DEET:						
- Yes	71 (22.4)	1.9 (1.2, 2.9)***	52 (23.3)	2.2 (1.3, 3.6)***	22 (21.8)	1.1 (0.5, 2.5)
- No	246 (77.6)		171 (76.7)		79 (78.2)	
Heard about Lyme disease:						
- Yes	435 (95.8)	4.1 (2.5, 6.8)****	293 (95.1)	3.9 (2.2, 6.8)****	155 (99.4)	12.7 (1.6, 98.5)**
- No	19 (4.2)		15 (4.9)		1 (0.6)	
Knows someone who has had Lyme disease:						
- Yes	156 (35.9)	2.0 (1.5, 2.6)****	82 (28.1)	1.7 (1.2, 2.5)**	98 (63.6)	2.4 (1.5, 3.8)****
- No	278 (64.1)		210 (71.9)		56 (36.4)	
Knows how someone gets Lyme:						
- Yes	379 (87.3)	1.7 (1.2, 2.4)**	250 (85.6)	1.4 (1.0, 2.1)*	145 (93.5)	4.0 (1.9, 8.6)****
- No	55 (12.7)		42 (14.4)		10 (6.5)	

Variable	U.S. (n=1750) ¹		U.S. excluding LD states (n=1247) ²		LD states (n=503) ³	
	N (%)	OR (95% CI) ⁴	N (%)	OR (95% CI)	N (%)	OR (95% CI)
Lyme disease is very to extremely serious illness:						
- Yes	347 (82.6)		239 (84.4)		114 (75.5)	
- No	73 (17.4)	1.5 (1.1, 2.0)**	43 (15.2)	1.8 (1.2, 2.7)**	37 (24.5)	0.7 (0.4, 1.2)*
Lyme disease is very to extremely serious illness for children (asked of respondents with children):						
- Yes	171 (96.6)		113 (98.3)		66 (91.7)	
- No	6 (3.4)	2.9 (1.1, 7.6)**	2 (1.7)	6.3 (1.4, 28.7)**	6 (8.3)	0.3 (0.0, 2.6)
Perceived likelihood respondent will ever get Lyme disease (0=never, 100=definitely):						
0-50	369 (87.2)		248 (87.3)		132 (86.3)	
51-100	54 (12.8)	0.4 (0.3, 0.7)****	36 (12.7)	0.4 (0.2, 0.7)****	21 (13.7)	0.7 (0.3, 1.5)
Perceived likelihood respondent's children will ever get Lyme disease (0=never, 100=definitely):						
0-50	128 (76.2)		83 (76.9)		51 (75.0)	
51-100	40 (23.8)	0.4 (0.2, 0.8)***	25 (23.1)	0.4 (0.2, 0.8)**	17 (25.0)	0.7 (0.3, 2.0)
R would buy Lyme disease vaccine: ⁵						
at \$50 cost						
- Yes	90 (50.6)		57 (47.9)		37 (56.9)	
- No	88 (49.4)	1.7 (1.1, 2.5)***	62 (52.1)	1.9 (1.2, 3.2)***	28 (43.1)	0.8 (0.4, 1.7)
at \$100 cost						
- Yes	113 (59.2)		77 (58.3)		40 (64.5)	
- No	78 (40.8)	3.1 (2.1, 4.6)****	55 (41.7)	3.1 (2.0, 5.0)****	22 (35.5)	3.5 (1.7, 7.6)***
R reads newspaper regularly:						
- Yes	341 (74.9)		230 (74.4)		121 (78.1)	
- No	114 (25.1)	1.5 (1.2, 2.0)***	79 (25.6)	1.5 (1.1, 2.1)**	34 (21.9)	1.63 (0.9, 2.7)*
Reads newspaper more than 4 days/wk:						
- Yes	233 (69.1)		153 (67.4)		91 (75.2)	
- No	104 (30.9)	0.8 (0.5, 1.0)*	74 (32.6)	0.67 (0.5, 1.0)**	30 (24.8)	1.1 (0.6, 1.9)
Has dogs only as pets:						
- Yes	142 (52.2)		101 (56.4)		41 (39.4)	
- No	130 (47.8)	2.0 (1.5, 2.7)****	78 (43.6)	2.3 (1.6, 3.2)****	63 (60.6)	1.6 (0.9, 2.7)*
Has cats only as pets:						
- Yes	77 (37.2)		47 (37.6)		35 (35.7)	
- No	130 (62.8)	2.9 (2.0, 4.3)****	78 (62.4)	3.1 (1.9, 5.1)****	63 (64.3)	2.2 (1.2, 4.1)**
Has both dogs and cats as pets:						
- Yes	106 (44.9)		83 (51.6)		17 (21.3)	
- No	130 (55.1)	2.2 (1.6, 3.1)****	78 (48.4)	2.7 (1.8, 3.9)****	63 (78.8)	1.7 (0.8, 3.6)

Variable	U.S. (n=1750) ¹		U.S. excluding LD states (n=1247) ²		LD states (n=503) ³	
	N (%)	OR (95% CI) ⁴	N (%)	OR (95% CI)	N (%)	OR (95% CI)
Type of home:						
- Single house OR	345 (77.4)	1.4 (1.1, 1.9)**	346 (80.1)	1.6 (1.1, 2.2)**	98 (67.6)	1.2 (0.7, 1.9)
- Row-Townhouse-Duplex - Apt/Condo	101 (22.6)		61 (19.9)		47 (32.4)	
Location where R lives:						
- City	109 (47.6)	0.8 (0.6, 1.1)	76 (52.4)	0.9 (0.6, 1.3)	36 (35.6)	0.8 (0.4, 1.4)
- Suburb	120 (52.4)		69 (47.6)		65 (64.4)	
Location where R lives:						
- Small town	86 (39.6)	0.6 (0.4, 0.8)***	62 (38.5)	0.6 (0.4, 1.0)**	22 (45.8)	0.5 (0.3, 1.2)*
- Rural area	131 (60.4)		99 (61.5)		26 (54.2)	
Location where R lives:						
- City	109 (45.5)	0.6 (0.4, 0.8)***	76 (43.4)	0.6 (0.4, 0.9)**	22 (45.8)	0.6 (0.3, 1.1)*
- Rural area	131 (54.6)		99 (56.6)		26 (54.2)	
Location where R lives:						
- Suburb	120 (58.3)	1.3 (0.9, 1.8)*	69 (52.7)	1.1 (0.7, 1.7)	65 (74.7)	2.0 (1.0, 3.7)
- Small town	86 (41.7)		62 (47.3)		22 (25.3)	
Respondent's race:						
- White	398 (89.6)	1.6 (1.1, 2.4)**	275 (90.5)	1.8 (1.2, 2.9)**	129 (90.2)	1.1 (0.6, 2.1)
- Black or other	46 (10.4)		29 (9.5)		20 (13.4)	
Household income:						
- Less than \$12,000	177 (51.3)	0.8 (0.6, 1.1)*	128 (54.0)	0.9 (0.7, 1.2)	49 (41.2)	0.8 (0.5, 1.4)
- \$50,001 or more	168 (48.7)		109 (46.0)		70 (58.8)	
Respondent's age:						
- 18 to 44	262 (59.5)	1.1 (0.8, 1.4)	179 (59.9)	1.1 (0.8, 1.4)	91 (60.7)	1.5 (1.0, 2.4)*
- 45 and older	178 (46.5)		120 (40.1)		59 (39.3)	

1. Cases weighted by WT

2. Non-LD states excluded Connecticut, Delaware, New Jersey, New York, Pennsylvania, and Rhode Island; cases weighted by LYMEWT.

3. LD states included Connecticut, Delaware, New Jersey, New York, Pennsylvania, and Rhode Island; cases weighted by LYMEWT.

4. 95% confidence interval.

5. Respondents had an equal probability of vaccine cost being either \$50 or \$100.

*p<0.25, **p<0.05, ***p<0.01, ****p<0.001

Table 4 goes here

Individual Behaviors (OR, 95% CI)¹

Independent Variables	Sample ¹	Used repellent to avoid bites	Used repellent on skin	Used repellent on clothes	Wore long sleeves and long pants	Tucked pants into pants or boots	Stayed away from woods or grass	Did anything else to avoid ticks	Tick bite prevention index Measure ¹
R ² saw ticks last summer in own state and elsewhere - Yes = 1 - No = 0	I	1.20 (0.04, 2.24)	0.96 (0.50, 1.84)	1.04 (0.54, 1.98)	1.76 (0.93, 3.35)	3.21 (1.18, 7.46)**	2.18 (1.07, 4.43)*	2.50 (0.91, 6.90)	2.59 (1.45, 4.65)**
	II	1.39 (0.61, 3.21)	0.91 (0.39, 2.16)	0.95 (0.41, 2.21)	1.78 (0.74, 4.30)	3.77 (1.14, 12.52)*	3.05 (1.14, 8.25)*	2.89 (0.91, 6.90)	2.94 (1.36, 6.38)**
	III	0.91 (0.39, 2.79)	0.10 (0.31, 3.18)	2.32 (0.64, 8.41)	2.07 (0.65, 6.58)	2.14 (0.57, 8.12)	0.94 (0.28, 3.18)	8.73 (0.82, 92.78)	2.48 (0.67, 9.14)
R knew someone who has had Lyme disease - Yes - No	I	1.14 (0.68, 1.90)	0.91 (0.54, 1.54)	1.02 (0.61, 1.71)	0.79 (0.47, 1.32)	1.39 (0.80, 2.43)	1.23 (0.72, 2.11)	1.64 (0.88, 3.04)	1.26 (0.74, 2.15)
	II	0.81 (0.42, 1.56)	0.55 (0.27, 1.10)	0.78 (0.40, 1.49)	0.42 (0.21, 0.83)**	0.75 (0.36, 1.58)	0.89 (0.44, 1.78)	1.69 (0.80, 3.57)	0.73 (0.37, 1.44)
	III	2.82 (1.01, 7.95)*	2.13 (0.73, 6.17)	1.99 (0.66, 6.04)	1.36 (0.49, 3.72)	4.35 (1.36, 13.91)**	4.50 (1.46, 13.87)**	0.76 (0.14, 4.16)	4.09 (1.33, 12.56)**
R knows how someone gets Lyme disease - Yes - No	I	2.15 (0.91, 5.08)	1.47 (0.61, 3.53)	2.53 (0.95, 6.71)	1.61 (0.72, 3.62)	0.26 (0.11, 0.62)**	1.62 (0.68, 3.81)	1.03 (0.33, 3.15)	1.15 (0.54, 2.46)
	II	1.78 (0.60, 5.32)	1.06 (0.35, 3.26)	2.25 (0.67, 7.60)	0.76 (0.27, 2.10)	0.08 (0.02, 0.27)**	1.16 (0.39, 3.44)	0.84 (0.21, 3.42)	0.53 (0.20, 1.39)
	III	2.19 (0.49, 9.79)	1.85 (0.43, 8.21)	2.18 (0.37, 12.79)	1.92 (2.44, 79.13)**	5.70 (0.88, 36.70)	1.79 (0.34, 9.59)	7.36 (0.46, 117.96)	22.09 (3.57, 136.54)**
R believes Lyme disease is a somewhat to extremely serious illness - Yes - No	I	0.82 (0.44, 1.56)	0.93 (0.47, 1.82)	1.14 (0.58, 2.22)	1.81 (0.90, 3.61)	8.25 (2.62, 26.04)**	0.72 (0.36, 1.43)	0.96 (0.42, 2.16)	1.11 (0.60, 2.07)
	II	1.37 (0.60, 3.13)	1.72 (0.68, 4.36)	2.22 (0.89, 5.60)	5.08 (1.75, 14.70)**	29.73 (4.12, 214.61)**	1.13 (0.45, 2.79)	1.56 (0.54, 4.53)	2.56 (1.14, 5.73)*
	III	0.39 (0.12, 1.25)	0.38 (0.11, 1.26)	0.27* (0.08, 0.90)	0.46 (0.13, 1.55)	4.93 (1.10, 22.14)*	0.41 (0.12, 1.41)	0.05 (0.01, 0.43)**	0.10 (0.02, 0.50)**

Individual Behaviors (OR, 95% CI)^a

Sample^b

Table 4 Logistic regression analysis predicting an index measure and several self-reported behaviors to prevent tick bites, United States, 1998

Independent Variables	Used repellent to avoid bites	Used repellent on skin	Used repellent on clothes	Wore long sleeves and long pants	Tucked socks into pants or boots	Stayed away from woods or grass	Did anything else to avoid ticks	Tick bite prevention index Measure ^c
R is somewhat to very concerned to be bitten by ticks	I	5.72 (3.23, 10.14)***	5.09 (2.72, 9.52)***	3.30 (1.83, 5.94)***	6.90 (3.22, 14.79)***	7.48 (3.66, 15.31)***	4.61 (1.92, 11.06)***	7.48 (4.46, 12.55)***
	II	8.04 (3.81, 16.94)***	6.06 (2.70, 13.59)***	4.80 (2.22, 10.38)***	9.84 (3.26, 29.69)***	13.21 (4.77, 36.61)***	3.19 (1.18, 8.58)*	11.23 (5.78, 21.78)***
	III	1.98 (0.69, 5.67)	3.23* (1.04, 10.09)	1.01 (0.33, 3.09)	5.16** (1.75, 15.24)	8.31** (2.08, 33.25)	2.20 (0.71, 6.88)	89.64** (4.22, 1905.55)
R perceived likelihood he/she will ever get Lyme disease	I	2.66 (1.21, 5.85)**	2.08 (0.94, 4.60)*	2.44 (1.13, 5.26)*	1.90 (0.88, 4.09)	0.92 (0.36, 2.31)	0.76 (0.31, 1.86)	2.02 (0.86, 4.74)
	II	3.59 (1.32, 9.77)**	2.56 (0.94, 7.01)	3.00 (1.14, 7.91)*	1.73 (0.63, 4.76)	0.70 (0.20, 2.49)	0.62 (0.18, 2.13)	2.80 (0.94, 8.28)
	III	1.08 (0.29, 4.04)	1.06 (0.26, 4.07)	1.57 (0.41, 6.00)	1.60 (0.42, 6.06)	0.82 (0.20, 3.46)	1.05 (0.29, 3.76)	0.55 (0.09, 3.43)
R believes staying away from woods is somewhat to very effective	I	0.44 (0.15, 1.25)	0.32 (0.11, 0.95)*	0.88 (0.30, 2.58)	1.29 (0.39, 4.25)	2.19 (0.57, 8.43)	1.54 (0.43, 5.54)	4.67 (0.64, 34.39)
	II	0.42 (0.12, 1.51)	0.30 (0.08, 1.06)	1.12 (0.31, 4.05)	1.41 (0.31, 6.39)	2.58 (0.40, 16.52)	2.23 (0.42, 11.78)	4.23 (0.39, 45.43)
	III	0.37 (0.03, 4.96)	0.19 (0.01, 3.28)	0.21 (0.01, 3.28)	1.75 (0.15, 20.35)	3.11 (0.25, 38.87)	2.06 (0.19, 22.47)	9.58 (0.06, 1492.63)
R believes using insect repellent is somewhat to very effective	I	5.61 (2.97, 10.60)***	4.42 (2.33, 8.76)***	3.50 (1.83, 6.69)***	0.52 (0.30, 0.89)**	0.60 (0.33, 1.09)	0.69 (0.39, 1.23)	1.22 (0.61, 2.41)
	II	6.90 (3.07, 15.51)***	5.57 (2.31, 13.40)***	4.07 (1.83, 9.06)***	0.42 (0.21, 0.85)**	0.51 (0.24, 1.08)	0.62 (0.30, 1.27)	1.14 (0.50, 2.62)
	III	5.96 (1.70, 20.77)**	5.45 (1.36, 21.82)*	5.39 (1.38, 21.10)**	1.20 (0.41, 3.55)	1.46 (0.45, 4.73)	0.84 (0.27, 2.58)	1.51 (0.29, 7.85)

Individual Behaviors (OR, 95% CI)¹

Sample¹

Independent Variables	Used repellent to avoid bites	Used repellent on skin	Used repellent on clothes	Wore long sleeves and long pants	Tucked socks into pants or boots	Stayed away from woods or grass	Did anything else to avoid ticks	Tick bite prevention index Measure ¹
R believes wearing long pants/sleeves somewhat to very effective. - Yes - No	I	0.84 (0.45, 1.58)	1.87 (0.93, 3.76)	1.04 (0.55, 1.97)	6.60 (3.05, 14.28)***	2.90 (1.33, 6.32)**	2.65 (1.25, 5.63)**	1.66 (0.89, 3.09)
	II	0.75 (0.35, 1.62)	2.07 (0.89, 4.81)	0.98 (0.46, 2.08)	10.31 (3.74, 28.38)***	4.09 (1.49, 11.23)**	2.94 (1.17, 7.36)*	1.45 (0.57, 3.65)
	III	1.23 (0.24, 6.23)	1.75 (0.27, 11.22)	1.16 (0.20, 6.77)	1.23 (0.27, 5.57)	0.50 (0.11, 2.40)	0.83 (0.16, 4.34)	0.11 (0.01, 0.96)*
R knows repellent used contains the chemical DEET. - Yes = 1 - No/not sure = 0	I	1.74 (0.99, 3.05)*	1.67 (0.94, 2.94)	2.06 (1.19, 3.57)**	0.89 (0.50, 1.59)	0.77 (0.41, 1.48)	0.86 (0.46, 1.62)	1.83 (0.97, 3.36)
	II	1.66 (0.83, 3.31)	1.98 (0.98, 3.99)	1.88 (0.96, 3.70)	1.27 (0.61, 2.62)	0.88 (0.40, 1.96)	1.05 (0.50, 2.18)	1.90 (0.87, 4.12)
	III	2.87 (0.95, 8.68)	1.38 (0.46, 4.15)	4.41 (1.48, 13.17)**	0.28 (0.09, 0.87)*	0.44 (0.12, 1.66)	0.26 (0.07, 0.97)*	5.39 (1.07, 27.06)*
R reads newspapers regularly. - Yes = 1 - No = 0	I	1.41 (0.81, 2.45)	1.04 (0.59, 1.82)	1.10 (0.63, 1.91)	1.79 (1.04, 3.09)*	1.12 (0.63, 2.02)	1.93 (1.05, 3.53)*	1.37 (0.69, 2.74)
	II	1.34 (0.68, 2.67)	1.00 (0.50, 2.02)	1.04 (0.53, 2.06)	2.18 (1.07, 4.44)*	1.16 (0.54, 2.48)	2.04 (0.94, 4.41)	2.10 (0.85, 5.17)
	III	1.94 (0.70, 5.40)	1.66 (0.59, 4.68)	1.32 (0.45, 3.85)	1.42 (0.50, 4.02)	0.70 (0.23, 2.17)	2.36 (0.78, 7.15)	0.14 (0.03, 0.67)**
R has dogs and/or cats. - Yes - No/pets	I	1.73 (1.01, 2.96)*	1.46 (0.81, 2.55)	1.18 (0.68, 2.04)	1.66 (0.97, 2.86)	2.08 (1.11, 3.90)*	0.79 (0.46, 1.38)	1.56 (0.77, 3.16)
	II	2.20 (1.09, 4.47)*	1.60 (0.77, 3.33)	1.37 (0.68, 2.79)	1.72 (0.83, 3.59)	2.02 (0.85, 4.83)	0.67 (0.32, 1.19)	1.76 (0.69, 4.49)
	III	0.99 (0.41, 2.34)	1.22 (0.50, 2.97)	0.75 (0.30, 1.89)	1.68 (0.69, 4.09)	3.20 (1.15, 8.92)*	0.97 (0.40, 2.35)	1.11 (0.28, 4.36)
Marital status. - Married = 1 - Not married = 0	I	0.60 (0.36, 1.00)*	0.69 (0.41, 1.13)	1.39 (0.82, 2.35)	0.64 (0.36, 1.07)	1.43 (0.79, 2.60)	0.70 (0.41, 1.20)	1.09 (0.58, 2.07)
	II	0.53 (0.28, 1.01)*	0.64 (0.34, 1.21)	1.47 (0.77, 2.79)	0.50 (0.26, 0.96)*	1.44 (0.68, 3.05)	0.61 (0.31, 1.18)	1.04 (0.48, 2.24)
	III	0.89 (0.32, 2.51)	0.78 (0.27, 2.23)	1.49 (0.47, 4.69)	0.86 (0.30, 2.41)	0.88 (0.26, 2.97)	0.99 (0.35, 2.83)	1.53 (0.20, 11.55)

Individual Behaviors (OR, 95% CI)¹

Sample²

Independent Variables	Used repellent to avoid bites	Used repellent on skin	Used repellent on clothes	Wore long sleeves and long pants	Tucked socks into pants or boots	Stayed away from woods or grass	Did anything else to avoid ticks	Tick bite prevention index Measure ³
Type of home: - Single family house = 1 - Other = 0 (Row)	1.12 (0.72, 2.42)	1.01 (0.56, 1.91)	0.90 (0.49, 1.67)	0.99 (0.55, 1.80)	0.44 (0.23, 0.85)**	0.70 (0.40, 1.29)	1.15 (0.52, 2.52)	0.89 (0.47, 1.66)
Townhouse-Duplex	1.70 (0.74, 3.89)	1.24 (0.54, 2.89)	1.34 (0.58, 3.09)	1.39 (0.61, 3.15)	0.57 (0.24, 1.38)	0.74 (0.32, 1.66)	1.22 (0.42, 3.55)	0.86 (0.36, 2.04)
III	1.13 (0.44, 2.88)	1.16 (0.45, 2.98)	0.44 (0.16, 1.20)	1.27 (0.51, 3.20)	0.75 (0.27, 2.12)	0.77 (0.30, 1.98)	1.02 (0.21, 4.92)	2.64 (0.84, 8.26)
Location where R lives: - City or suburb = 1 - Small town or rural area = 0	1.07 (0.66, 1.73)	1.34 (0.81, 2.22)	1.07 (0.65, 1.74)	0.76 (0.46, 1.24)	1.49 (0.86, 2.58)	0.53 (0.32, 0.90)*	2.10 (1.13, 3.90)*	1.02 (0.62, 1.67)
II	1.23 (0.67, 2.25)	1.99 (1.03, 3.84)*	1.08 (0.59, 1.98)	1.18 (0.61, 2.27)	2.17 (1.05, 4.52)**	0.53 (0.27, 1.03)	3.34 (1.49, 7.53)**	1.26 (0.67, 2.36)
III	0.54 (0.22, 1.34)	0.47 (0.18, 1.20)	0.91 (0.35, 2.35)	0.40 (0.16, 1.00)*	1.21 (0.45, 3.27)	0.62 (0.24, 1.59)	0.58 (0.14, 2.33)	0.54 (0.19, 1.55)
Respondent's race: - White = 1 - Non-white = 0	0.99 (0.41, 2.39)	1.41 (0.55, 3.59)	0.87 (0.35, 2.13)	1.44 (0.59, 3.48)	0.43 (0.17, 1.12)	0.50 (0.21, 1.17)	0.69 (0.20, 2.29)	0.80 (0.34, 1.89)
II	0.86 (0.28, 2.64)	1.33 (0.41, 4.37)	0.83 (0.27, 2.55)	2.27 (0.67, 7.62)	0.61 (0.17, 2.17)	0.49 (0.17, 1.44)	0.40 (0.09, 1.75)	0.88 (0.29, 2.71)
III	1.17 (0.28, 4.99)	1.65 (0.35, 7.69)	1.33 (0.25, 6.93)	0.58 (0.13, 2.63)	0.20 (0.03, 1.13)	0.61 (0.13, 2.80)	ns	1.10 (0.20, 6.07)

1. OR = adjusted odds ratio, CI=confidence interval

2. I = U.S. sample, cases weighted by WT, II = U.S. sample excluding Connecticut, Delaware, New Jersey, New York, Pennsylvania, and Rhode Island, cases weighted by LYMEWT, III = Over sampled states of Connecticut, Delaware, New Jersey, New York, Pennsylvania, and Rhode Island, cases weighted by LYMEWT

3. The index measure for the prevention of tick bites equals the sum of seven behavioral variables (where respondent stated they had performed the action coded no = 0 and yes = 1) plus the sum of five frequency of action variables (where respondent stated they had performed the action "occasionally vs. sometimes vs. often," coded 0 and 1 respectively) that yielded an action score (range 0 to 12). The index measure was dichotomized and coded such that "action" equaled scores greater than or equal to 1 and no action equaled scores of 0

ns = respondent

*p<0.05, **p<0.01, ***p<0.001

Figure 1 goes here

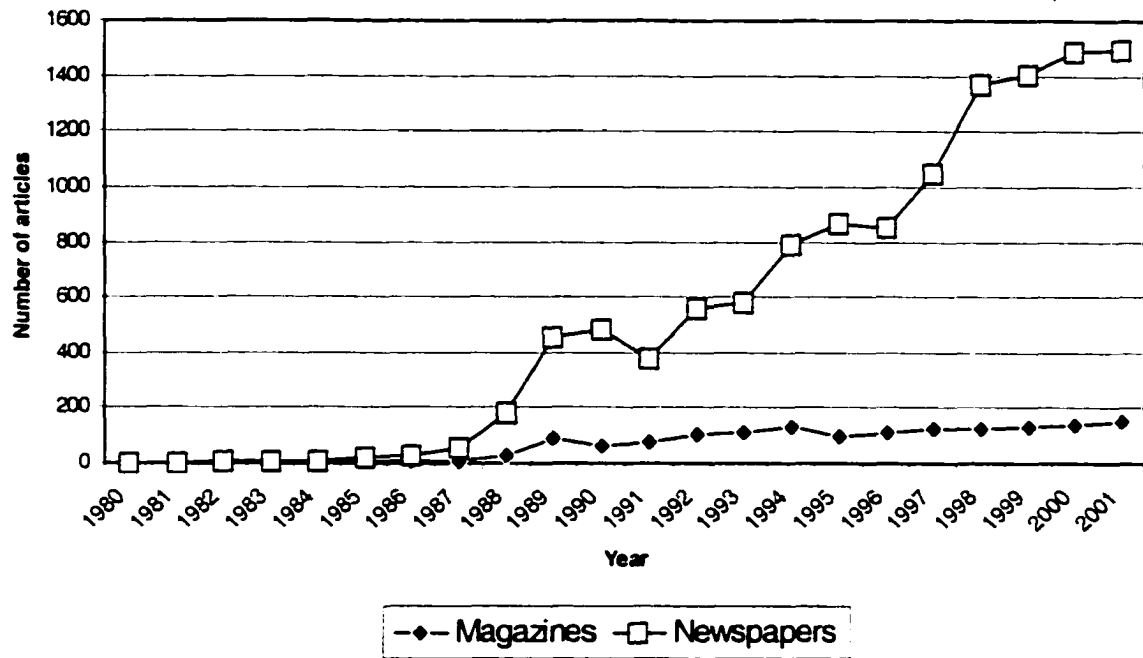


Figure 1. Articles on Lyme disease appearing in newspapers and magazines, United States, 1980-2001 (Lexis-Nexis Academic Universe 2002).

CHAPTER 5

Publishable Manuscript #2 (~ 6500 words; 4 tables/figures)

Risk Perceptions of Mosquitoes and Viral Encephalitis

Introduction

Arthropods, such as mosquitoes and ticks, transmit a variety of viruses that cause inflammation of the human brain or encephalitis (Monath TP 1989; Gubler DJ 1996). These “arboviruses” (meaning arthropod-borne virus) exist in a complex natural life cycle that involves nonhuman vertebrate hosts, such as birds, and an arthropod vector, such as a mosquito (Monath TP 1989; Gubler DJ 1998). Mosquitoes acquire the viruses while taking a bloodmeal (male mosquitoes feed on plant nectar only) from vertebrate hosts and then transmit the viruses to other vertebrates, such as birds, horses, and humans, when taking additional bloodmeals (Nasci RS et al. 1993; Nasci RS and Moore CG 1998). Transovarial transmission also occurs in some mosquito species, whereby viruses are passed to the female’s eggs such that the emergent mosquitoes are infected without having taken a bloodmeal from an infected host (Nasci RS et al. 1993; Nasci RS and Moore CG 1998).

Passive arboviral surveillance data collected in the U.S. reported 8,269 cases

of arboviral encephalitis from 1964 through 2001,ⁱ of which St. Louis encephalitis comprised 54.3% of reported cases, LaCrosse encephalitis 35.2%, Western equine encephalitis 7.5%, eastern equine encephalitis 2.2%, and West Nile virus 0.8%, respectively. The trend of reported cases of arboviral encephalitis reveals that St. Louis encephalitis and LaCrosse encephalitis infections were the most frequently reported of the four major encephalitides, with an annual mean of 121 and 75 cases, respectively, for the 38 year period 1964-2001 (Figure 1) (Centers for Disease Control and Prevention 1998g; Centers for Disease Control and Prevention 1998e; Centers for Disease Control and Prevention 1998d; Centers for Disease Control and Prevention 1998f). Unlike morbidity data, arboviral encephalitides mortality data are not routinely collected by the National Electronic Telecommunications System for Surveillance (NETSS) (Centers for Disease Control and Prevention 1995a).

Symptoms of arboviral encephalitis infection include headache, fever, nausea, dehydration, seizures, paralysis, coma, and death (rarely) (Centers for Disease Control and Prevention 1999g; Centers for Disease Control and Prevention 1997a; Centers for Disease Control and Prevention 1999c). Children and the elderly are at greatest risk for poor clinical outcome (Centers for Disease Control and Prevention, 1999c; Centers for Disease Control and Prevention, 1999g). Long-term sequelae of encephalitis infection include nervousness, learning difficulties, auditory and visual degradation,

ⁱ Data for 2001 are preliminary (Campbell G, CDC, personal communication).

hyperactivity, personality problems, emotional instability, and seizures (Centers for Disease Control and Prevention 1999g; Hayes C 1989; Centers for Disease Control and Prevention 1997a; Centers for Disease Control and Prevention 2000a). Viruses that cause human encephalitis are from three viral families: Bunyaviridae, Flaviviridae and Togaviridae (genus Alphavirus) (Monath TP 1989).

Dengue is a vector-borne viral illness transmitted in tropical urban and periurban settings principally by the mosquito Aedes aegypti and, to a lesser extent, in rural areas by the mosquito Aedes albopictus, both of the Stegomyia subgenus (Gubler DJ 1997a). Aedes aegypti is common in central and south America and the Gulf Coast states of the United States (World Health Organization 1998; Innis BL 1995; Gubler DJ 1997b). After an absence of 35 years, autochthonous dengue transmission has occurred five times in the United States: 1980, 1986, 1995, 1999, and 2001 (Gubler DJ 1997a; Centers for Disease Control and Prevention 1996a; Centers for Disease Control and Prevention 1999b). Active surveillance along the U.S.-Mexico border in Texas identified seven cases of autochthonous dengue fever in 1995 (Centers for Disease Control and Prevention 1996a). During January to July 1999, approximately 300 to 325 dengue cases were reported from Nuevo Laredo, Tamaulipas, Mexico (1999 population: 274,000), a city across the Rio Grande river from Laredo, Texas (Centers for Disease Control and Prevention 2001c). Dengue has also been reported in Florida among persons who have traveled to the Caribbean where dengue is endemic on many islands (Centers for Disease Control and Prevention 1999b).

Moreover, beginning in 2001 and through February 2002, 108 cases of locally acquired dengue fever were confirmed in the state of Hawaii for the first time in 50 years (Duffy DC 2001; Sasaki DM and Tom T 2002). Dengue is endemic in Puerto Rico (Gubler DJ 1997a) with the number of reported cases during five nonepidemic years (1992, 1993, 1995, 1996, and 1997) ranging from 4,645 to 11,078 (mean rate of 2.0 cases per 1000 population). During the 1994 epidemic, 23,693 cases were reported (6.7 per 1000 population) while during the recent 1998 epidemic, there were 9,803 cases reported (2.8 per 1000 population) of which 4,677 (47.7%) were diagnosed as dengue by virologic or serologic testing, 526 (5.4%) were negative, and 4600 (46.9%) were indeterminate (Centers for Disease Control and Prevention 1998h).

There are two known natural life cycles of dengue viruses. One is an enzootic forest cycle involving non-human primates (i.e., monkeys) and Aedes-complex forest canopy dwelling mosquitoes. The other is an endemic urban/periurban cycle involving humans and domestic, urban dwelling Aedes aegypti mosquitoes. In the forest cycle non-human primates are probably the reservoir for dengue viruses. In the urban/periurban cycle, humans are the primary reservoir (Gubler DJ 1997a; Halstead SB 1994; Innis BL 1995).

Clinically, dengue fever presents with sudden onset, fever for 3-5 days (but usually not lasting not more than 7 days), intense headache, muscle and joint pain, eye pain, gastrointestinal disturbances, and a rash that is visible in light-skin colored persons

(Innis BL 1995). The hemorrhagic form of dengue fever (DHF) is a severe illness, recognized primarily in children, and endemic in much of South and Southeast Asia, the Pacific, and Latin America (Halstead SB 1990; Gubler DJ 1997a; Gubler DJ 1997b). DHF is characterized by abnormal vascular permeability, hypovolemia, and abnormal blood clotting (Benenson AS 1995; Innis BL 1995). DHF can be a fatal disease without supportive treatment to replace fluids lost from plasma leakage (Benenson AS 1995).

In August 1999, an arboviral encephalitis outbreak was recognized in New York City and in contiguous counties in New York state. Positive serologic findings in human cerebrospinal fluid (CSF) and serum samples initially led to the outbreak being attributed to St. Louis encephalitis (SLE) virus (Centers for Disease Control and Prevention 1999c). Further analysis of virus recovered from human, avian, and mosquito samples revealed West Nile virus (WNV), an agent (Shope RE 1999) previously not known to occur in North America (Centers for Disease Control and Prevention 1999g; Hayes C 1989; Centers for Disease Control and Prevention 1999c; Hubálek Z and Halouzka J 1999). By November 1999, 56 (31 confirmed and 25 probable) cases of WNV infection had been identified, including seven deaths (Centers for Disease Control and Prevention 1999c). It was further determined that WNV overwintered in mosquito vectors in the Northeastern U.S., primarily Culex species (Centers for Disease Control and Prevention 2000d; Centers for Disease Control and Prevention 2000b). Active surveillance in 1999 for WNV in 17 states along the

Eastern seaboard and Gulf of Mexico revealed WNV infection in mosquitoes, sentinel chicken flocks, wild birds, and potentially susceptible mammals, such as horses and humans (Centers for Disease Control and Prevention 2000e).

During 2000, 14 persons from New York state and four from New Jersey were hospitalized with severe central nervous system illnesses caused by WNV. The age of these 18 patients ranged from 36 to 87 years (mean: 62 years) with 67% being men. The onset dates for illness in this population were in late summer (July 20 to September 13). There was one fatality among the 18 patients (case fatality rate: 6%). Another patient was in a persistent vegetative state (Centers for Disease Control and Prevention 2000g; Centers for Disease Control and Prevention 2000f; Centers for Disease Control and Prevention 2001a). The WNV epizootic has persisted in the four states originally affected in 1999 (Connecticut, Maryland, New York, and New Jersey) and had expanded in 2000 into eight additional states (Delaware, Massachusetts, New Hampshire, North Carolina, Pennsylvania, Rhode Island, Vermont, and Virginia) and the District of Columbia. While 18 humans with encephalitis attributed to WNV were reported in 2000 compared with 62 in 1999, less than 1% of infected persons will demonstrate severe neurologic illness, suggesting that approximately 2000 persons may have been infected, but were asymptomatic during 2000 (Centers for Disease Control and Prevention 2000g; Centers for Disease Control and Prevention 2000f; Centers for Disease Control and Prevention 2001a). It is anticipated that widespread WNV epizootic activity will most likely persist and expand in the United States with larger

outbreaks of WNV infection and human illness possible (Centers for Disease Control and Prevention 2000a). Thus, active surveillance for the spread of WNV in animals and humans, as well as behavioral risk factors that may increase or decrease the risk of human and animal illness, will be important in the control of WNV exposure.

While much is known about the ecology, epidemiology, and clinical manifestations of the arboviral encephalitides (Hayes C 1989; Centers for Disease Control and Prevention 1997a; Hubálek Z and Halouzka J 1999; Gubler DJ 1998), little empirical research exists regarding the general public's knowledge of mosquitoes or arboviral encephalitis, perceptions regarding the severity of and susceptibility to these infections, and attitudes regarding recommendations for prevention of mosquito bites as proposed by federal (Centers for Disease Control and Prevention 2000a), state (Connecticut Department of Environmental Protection 2002), and local (New York City Department of Health 2001) government agencies and national medical associations (Fradin MS 1998).

Methods and materials

A U.S. survey on vector-borne infectious diseases was developed and administered by the Survey Research Center, University of Maryland at College Park, in collaboration with the U.S. Centers for Disease Control and Prevention (CDC) (Survey Research Center 1998). The survey consisted of 55 items, based on extensive focus-group research and pretesting (Survey Research Center 1998; Survey Research Center 1997) and was administered using a computer assisted telephone interview

system. This study drew two samples: a cross-section, designed to yield 1,500 interviews from the 48 contiguous states plus the District of Columbia, and an over-sample, designed to yield 250 additional interviews from six Northeastern states with high incidence of reported cases of Lyme Disease, a tick-borne bacterial illness common in Connecticut, Delaware, Rhode Island, New Jersey, New York, and Pennsylvania (Centers for Disease Control and Prevention 2000c).

In 1998, at the time of this study, the outbreak of West Nile viral encephalitis (WNV) in the New York City metropolitan area had not occurred (Centers for Disease Control and Prevention 1999g; Centers for Disease Control and Prevention 1999c). Serendipitously, the over-sampled Northeastern states for the present study were also affected by the WNV outbreak (Centers for Disease Control and Prevention 2000g; Centers for Disease Control and Prevention 2000d; Centers for Disease Control and Prevention 2000b; Centers for Disease Control and Prevention 2000e; Centers for Disease Control and Prevention 2000f; Centers for Disease Control and Prevention 2001a). Thus, the over-sample data set (in addition to the national data set) was also used to analyze those variables pertaining to mosquitoes and arboviral encephalitis. As a result, this analysis provides a unique baseline of knowledge, attitudes, and practices regarding mosquitoes and arboviral encephalitis in Connecticut, Delaware, New Jersey, New York, Pennsylvania, and Rhode Island prior to the 1999 WNV that occurred in the Northeastern United States and by late 2000 had spread as far north as New Hampshire and Vermont and as far south as North Carolina (New

York City Department of Health 2001).

For the U.S. cross-sectional sample, interviewers dialed 4,200 random telephone numbers and successfully interviewed 1,489 eligible persons aged 18 years or older living in private residences, yielding a 60% cross-sectional response rate (completed interviews divided by eligibles). For the NE states over-sample, interviewers made 800 random telephone calls and successfully interviewed 261 eligible persons aged 18 years or older living in private residences yielding a 52% over-sample response rate (completed interviews divided by eligibles). A list-assisted random digit dial frame was used to obtain the numbers called. The “next birthday” selection method was used to select one respondent per household (Oldendick and et al 1988). The overall sample standard error was 2.9%.

Post-stratification design weights were developed for the demographic variables of sex, age, education, race, and census region. This corrects the sample distributions on these variables to resemble those of the United States population based on data collected by the U.S. Census Bureau (U.S. Census Bureau 1997b; U.S. Census Bureau 1997a). An overall weight was used for all analyses that combine the cross-sectional and the over-sample. Analyses that compare respondents in the six NE states to those in the other 42 states and the District of Columbia (or analyses of only one of the two groups) used a second design weight.

SPSS® software was used to perform univariate and logistic regression analyses (1999). The chi-square statistic, with Yates correction (Fleiss JL 1981) was

used to compare proportions in 2 x 2 and 2 x n tables that considered the full U.S. sample, the U.S. sample excluding Connecticut, Delaware, New Jersey, New York, Pennsylvania, and Rhode Island, and the stratum that included the over-sampled states of Connecticut, Delaware, New Jersey, New York, Pennsylvania, and Rhode Island.

The variables of interest addressed by this study reflect the thematic areas common to theories of health behavior, namely, levels of knowledge about a given hazard, the perceived severity of the hazard, the perceived susceptibility to the hazard for others and for oneself, and the perceived effectiveness of recommended measures to prevent exposure to the hazard (Janz NK and Becker MH 1984; Becker MH 1974; Bandura A 1977; Ajzen I and Fishbein M 1980; Connors M and Norman P 1996; Weinstein ND 1988; Weinstein ND 1993; Bandura A 1995; Green LW and Kreuter MW 1991; Weinstein ND and Sandman PM (in press)). Thus, data were collected on the following variables: levels of knowledge of and experience regarding mosquitoes and arboviral encephalitis; perceived severity of arboviral encephalitis; the perceived susceptibility of being bitten by mosquitoes or getting arboviral encephalitis; the specific practices used to prevent mosquito bites and the frequency of these practices; the beliefs about the effectiveness of specific behaviors (regardless of personal practice) to prevent mosquito bites; the sources of information about arboviral encephalitis; the other prevention practices used (open-ended responses); the beliefs about the likelihood for oneself or one's children of getting sick from using insect repellent; and the knowledge of whether the repellent used contained the chemical DEET. Several

sociodemographic variables were also addressed, including newspaper readership and frequency, sources of news information, cat and dog ownership, international travel, education level, age, Hispanic origin, employment status, race, marital status, household size, residence type, urbanicity of residence, length of residence occupancy, health insurance status of respondent and respondent's household, household income, number of telephone numbers in the residence, and gender.

Independent variables were screened and those that were shown to be statistically significant ($p < 0.25$) and behaviorally plausible in association with self-reported behavior to prevent mosquito bites were entered into the logistic regression equation simultaneously (Hosmer DW and Lemeshow S 1989). The independent variables in the logistic regression model were dichotomized (1 for yes; 0 for no) for the following: Knowledge: saw mosquitoes the previous summer; heard about arboviral encephalitis. Perceived severity for others: knew someone who had arboviral encephalitis; knew how someone gets arboviral encephalitis; believed that arboviral encephalitis is a somewhat to very serious illness. Perceived susceptibility for self: was somewhat to very concerned about being bitten by mosquitoes; believed there was a high likelihood of ever getting arboviral encephalitis. Perceived effectiveness of precautions available: believed that staying indoors in the late afternoon or early evening, using insect repellent on skin or clothes, and wearing long sleeves and long pants were somewhat to very effective prevention methods; and knew whether the insect repellent used contained the chemical DEET. Sociodemographic variables that

were shown by the univariate analyses to be statistically significant ($p < 0.25$) were also entered into the logistic regression equation simultaneously (Menard S 1995).

Logistic regression analyses were performed in order to ascertain, within a 95% level of confidence and while adjusting for confounding factors, which independent variables would be predictive of respondents' self-reported mosquito-bite prevention practices, namely, to use insect repellent to prevent mosquito bites; to use insect repellent on one's skin; to use insect repellent on one's clothes; to stay indoors in late afternoon and early evening; to wear long sleeves and long pants; and/or, to indicate having done anything else to avoid mosquitoes.

An index measure was developed to represent the combination and frequency of performing the specific behaviors an individual may use to prevent mosquito bites. Those respondents who indicated they had done something to prevent mosquito bites were asked whether and how often they performed the specific behaviors. The index measure for the prevention of mosquito bites was created by summing the positive responses (coded 0 for no and 1 for yes) to any of the following six behavior variables: 1) repellent use to prevent bites; 2) repellent use on skin; 3) repellent use on clothes; 4) staying indoors in late afternoon and early evening; 5) wearing long sleeves and long pants; 6) doing anything else to prevent mosquito bites. This value was then added to the sum of the positive responses from the individual who responded as having performed behaviors 2 through 6 above "occasionally" (coded 0) or "sometimes or often" (coded 1). The tally of the behavioral variables plus the frequency of action

variables yielded an individual action score ranging from 0, for performing none of the behaviors, to 11, for performing all the behaviors with more than occasional frequency. The index measure was then dichotomized and coded 0 for “no action,” for individual summary scores equaling zero, and coded 1 for “action,” for individual summary scores greater than or equal to 1 because the individual either did or did not perform the behavior. Although power may be lost with binary data, mosquito bites preventive behaviors are either performed or not performed, similar to seat belt use but unlike some chronic illnesses, such as arteriosclerosis, which can result from certain dietary or smoking behaviors that over time may have cumulative and deleterious effects on an individual’s health. Thus, it would be biologically reasonable to use continuous or categorical measures in the latter case, but not necessarily so with the mosquito bite prevention index.

Sample description

The overall study sample of 1,750 eligible persons consisted of an almost equal number of men (47%) and women (53%), a greater proportion of married persons (60.7%), and was predominately White (84.1%). About half of the sample was employed full-time (54.5%) and reported having completed high school (51.1%). Almost three-fourths lived in single family homes (71.7%) with an average length of occupancy of 11.8 years. The majority of respondents reported having an annual household income of at least \$50,000 (54.8%). The average age of respondents was 45 years. Almost nine of 10 respondents indicated their families had health insurance

coverage (86%). When comparing the U.S. sample excluding the six high incidence arboviral encephalitis states with the six high incidence arboviral encephalitis states group on sociodemographic variables, statistically significant ($p < 0.25$) differences were observed on the following: reads newspaper regularly ($p = 0.108$), pet ownership ($p = 0.0001$), employment status ($p = 0.008$), reason for unemployment ($p = 0.021$), type of home ($p = 0.001$), location where respondent lives ($p = 0.0001$), years at current residence ($p = 0.0001$), insurance coverage ($p = 0.038$), and household income ($p = 0.121$) (data not shown).

Results

Among the U.S. sample of 1750 adults age 18 years or older, 77% of respondents had seen mosquitoes the previous summer, mostly in the respondent's state, of whom 43% said they were somewhat to very concerned about being bitten (Table 1). A total of 922 (69%) reported they did anything to avoid being bitten, of whom 80% reported using an insect repellent. Of these, 679 (91%) reported they used insect repellent on their skin. Twenty-six percent stated they used insect repellent often on their skin. Of those reporting insect repellent use, 59% stated they used it on their clothes often (27%) (Table 1). Slightly more than one-third (36%) of all 1750 respondents thought that insect repellent was very effective in preventing mosquito bites.

Of the 922 respondents who stated they did anything to avoid being bitten by mosquitoes, 42% said they stayed indoors in the late afternoon or early evening when

Culex mosquitoes are most active (Centers for Disease Control and Prevention 2000a).

A total of 184 (48%) said they did this often. About two-fifths (39%) of all 1750 respondents believed that staying indoors during late afternoon and early evening was a very effective method for preventing mosquito bites. Forty-two percent of the 922 respondents who reported doing anything to avoid mosquito bites stated they wore long sleeves and long pants, of whom 177 (44%) said they did this often. One-third (33%) of all 1750 respondents perceived that wearing long sleeves and long pants was a very effective method of preventing mosquito bites.

Seventy-two percent of the 922 respondents who reported doing anything to avoid mosquito bites said they did something else to avoid mosquitoes. Of these open-ended responses, the most frequently cited included, burning/using citronella candles (Jensen T et al. 2000; Lindsay LR et al. 1996; Matsuda BM et al. 1996; U.S. Environmental Protection Agency 1999), spraying insecticide, emptying/draining water sites, and using Avon Skin-So-Soft™, a bath oil (Lindsay RL, Heal JD, and Surgeoner GA 1996).

All 1750 respondents, regardless of their personal behavior, were also asked if they thought that using an insect repellent could make an adult sick. Slightly less than half (45%) said this was somewhat to very likely and slightly more than half (55%) said this was not too or not at all likely. Among the 600 respondents who said they had children, the inverse relationship appeared to be the case with slightly more than half (56%) stating this was somewhat to very likely and slightly less than half (44%)

indicating it was not too or not at all likely. The active chemical ingredient N,N-diethyl-*m*-toluamide, commonly known as DEET, is found in many over-the-counter insect repellents intended for use on human skin (Fradin MS 1998). The combination of permethrin-treated clothing and DEET applied to skin can achieve almost 100% protection against insect bites (Fradin MS 1998). Citronella and Avon Skin-So-Soft™ bath oil have been shown in various controlled studies to be much less effective than DEET in preventing mosquito bites (Fradin MS 1998; Lindsay LR et al. 1996; Lindsay RL, Heal JD, and Surgeoner GA 1996). DEET has an exceptional safety record after over 40 years of worldwide use. However, toxic reactions have been reported when the product is not used according to manufacturer's labeled instructions (Fradin MS 1998; Garrettson LK 1997). A total of 788 respondents were asked if the repellent they used contained DEET. Less than one-fifth of respondents were certain that their repellent did (16%) or did not (19%) contain DEET.

Regarding encephalitis, 992 (57%) respondents of the U.S. sample reported having heard of the illness. Of these, 344 (35%) reported television as their primary source, while 29% stated their information source was newspapers or magazines, 8% reported hearing about encephalitis from their doctors, 1% reported radio as their source, while 22% reporting their source was from somewhere else, including friends, family members, co-worker, books, or personal experience. Similar results were observed for the U.S. sample excluding the six Northeastern (NE) states and for the over-sample of NE states (Table 1).

The 992 respondents who had heard about encephalitis were also asked to estimate their likelihood of ever getting encephalitis, using a continuous scale of 0 (never) to 100 (definitely). A total of 823 (94%) stated their likelihood of ever getting encephalitis was 50 or less on the 100 point scale (\bar{x} =24; SD=22.8), while 118 (6.7%) said they did not know. The 272 respondents who had heard about encephalitis and had children were asked to estimate their child's likelihood of ever getting encephalitis, using the same continuous scale. Ninety percent stated their children's likelihood of ever getting encephalitis was 50 or less on the 100 point scale (\bar{x} =29; SD=23.1), while 30 (1.7%) stated they did not know. Similar results were observed for the U.S. sample excluding the NE states and the over-sample of NE states.

Among the three sample strata, univariate analyses showed the following 12 variables to be statistically significantly ($p < 0.25$) associated with self-reported behavior to prevent mosquito bites: 1) having seen mosquitoes the previous summer, 2) being concerned about being bitten, 3) believing that insect repellent is effective, 4) believing that staying indoors in late afternoon and early evening is effective, 5) believing that insect repellent can make an adult sick, 6) perceiving that encephalitis is a serious illness, 7) having more than a high school education, 8) newspaper reading, 9) owning dogs or cats, 10) being married, 11) living in a single family home, and 12) being male (Table 2).

Crude odds ratios (OR) and 95% confidence intervals (CI) were calculated for univariate relationships between self-reported behavior to prevent mosquito bites

(coded No=0; Yes=1) and the independent variables described above for each sample stratum. Being somewhat to very concerned about being bitten by mosquitoes the previous summer was the factor found to be statistically significantly associated with the dependent variable across all three population groups surveyed (Table 2).

The following factors were observed to be statistically significantly associated with the dependent variable across both the U.S. and non-NE states groups: believing that using an insect repellent is a somewhat to very effective method for preventing mosquito bites; believing that staying indoors in late afternoon and early evening is a somewhat to very effective method of preventing mosquito bites; believing that encephalitis is a somewhat to extremely serious illness; owning dogs as pets; being married; and living in a single family home. For the U.S. sample, having heard about encephalitis, reading a newspaper less than four days per week, owning dogs and cats as pets, and being male were factors observed to be statistically significantly associated with the outcome variable (Table 2).

For the non-NE states group only, the following factors were observed to be statistically significantly associated with the dependent variable: respondents who had completed at least high school or some college education (Table 2). Not knowing if the insect repellent used contained DEET, not believing in a low likelihood of ever getting encephalitis, and owning cats as pets were factors observed to be statistically significantly associated with the dependent variable for the NE states group only (Table 2). Owning cats as pets was the only factor observed to be statistically significantly

associated with the dependent variable for both the U.S. group and the NE states group. Having seen mosquitoes the previous summer in the respondent's state and elsewhere was the only factor observed to approach statistical significance in being associated with the dependent variable for both the U.S. group and the non-NE states group (Table 2).

Multivariate Analyses

Several factors emerged from the logistic regression analyses that were predictive of respondents' self-reported practices to prevent mosquito-bites, both regarding specific practices and the mosquito-bite prevention index. In terms of knowledge and experience, respondents answered the questions "Did you see mosquitoes in your state or elsewhere last summer?" and "Have you heard of encephalitis?" Both these variables were constant for all selected cases in the logistic regression analysis and therefore removed by SPSS® from the regression equation. Even when forced into the logistic regression model, by requesting no constant in the equation, neither variable produced statistically significant results by sample level for any of the dependent variables.

Regarding perceived harm to others, respondents from the U.S. and non-NE states who knew how someone gets encephalitis were less likely to wear long sleeves and long pants as precautions against mosquito bites. Further, respondents from the U.S. and non-NE states who believed that encephalitis was a somewhat to extremely serious illness were less likely to do anything else to prevent mosquito bites even though

they indicated that encephalitis was perceived to be a somewhat to extremely serious illness, compared to the referent group of respondents who perceived that encephalitis was not too or not at all a serious illness (Table 3).

Regarding perceived harm to self, respondents from all three sample groups who indicated they were somewhat to very concerned to be bitten by mosquitoes were more likely to take preventive measures against mosquito bites, as measured by the mosquito-bite prevention index, to use insect repellent to avoid mosquito bites, to use insect repellent on skin, to use insect repellent on clothes, to stay indoors in late afternoon and evening, to wear long sleeves and long pants, and to report that they did anything else to prevent mosquito bites, as compared with the referent group of respondents that were not too or not at all concerned about being bitten by mosquitoes. High level of concern about being bitten by mosquitoes is the only independent variable that was strongly predictive of all seven dependent variables considered across all three sample groups (Table 3). In terms of respondents' perceived effectiveness of available precautions, those respondents from the NE states were less likely to wear long sleeves and long pants, compared with the referent group of respondents who believed that using an insect repellent was not too or not at all effective (Table 3).

Respondents who believed that staying indoors during late afternoon and evening was a somewhat to very effective method for preventing mosquito bites were more likely to report that they actually stayed indoors during late afternoon and evening among the U.S. respondents and NE states group. Respondents from the NE states

group who believed that staying indoors during late afternoon and early evening was a somewhat to very effective method for preventing mosquito bites were more likely to wear long sleeves and long pants, compared with the referent group of respondents who believed that staying indoors during late afternoon and evening was not too or not at all an effective method for preventing mosquito bites (Table 3).

Those respondents from the U.S. sample who believed it was not too or not all likely that insect repellent could make them sick were more likely to use insect repellent, use insect repellent on their skin, but less likely to wear long sleeves and long pants, and less likely to stay indoors in late afternoon and evening, when compared with the referent group of respondents who believed that it was somewhat to very likely that insect repellent could make them sick. Similarly, non-NE states respondents who believed it was not too or not all likely that insect repellent could make them sick were more likely to use insect repellent, and to use insect repellent on their skin, but less likely to wear long sleeves and long pants when compared with the referent group of respondents who believed that it was somewhat to very likely that insect repellent could make them sick. Respondents from the NE states group who believed it was not too or not all likely that insect repellent could make them sick were less likely to do anything else to prevent mosquito bites when compared with referent group (Table 3).

Certain sociodemographic and lifestyle factors also appear to be predictive of respondents' adopting precautions to prevent mosquito bites. Pet ownership (dogs and/or cats) among U.S. respondents was statistically significant in predicting use of

insect repellent, use of insect repellent on clothes, and doing anything else to prevent mosquito bites. Similar results were observed for respondents from the non-NE states in that pet ownership was statistically significant in predicting use of insect repellent on clothes, and having done anything else to prevent mosquito bites. For the NE states group, respondents who said they owned pets were more likely to use insect repellent on skin, when compared with respondents who reported not owning pets (neither dogs nor cats) (Table 3).

Respondents who reported being married were more likely to adopt precautions to prevent mosquito bites, as measured by the mosquito bite prevention index, to use insect repellent, to use insect repellent on skin, and to use insect repellent on clothes, when compared with respondents who reported not being married, i.e., were separated, divorced, widowed, or never married (Table 3). Respondents who reported living in a city or suburb were more likely to use insect repellent, to use insect repellent on skin, and to use insect repellent on clothes, when compared with respondents who reported living in a small town or rural area (Table 3).

Respondents who reported being between the age of 18 and 44 years old were more likely to adopt precautions against mosquito bites, when compared with the referent group aged 45 years and older, as measured by the mosquito-bite prevention index, to use insect repellent, to use insect repellent on skin, to use insect repellent on clothes, but less likely to stay indoors during later afternoon and evening (Table 3). Respondents from the U.S. sample who reported being White, as compared with the

referent group of Black or other race, were more likely to use insect repellent.

However, respondents from the non-NE states who reported being White were slightly less likely to stay indoors in late afternoon and evening, when compared with respondents who reported being non-White (Table 3). Having known someone who had encephalitis, reporting that the insect repellent used contained DEET, and being a regular newspaper reader were not significant or even marginally statistically significant predictors of any of the dependent variables considered.

Discussion and Conclusions

From a behavioral epidemiological perspective, it is important to understand what factors best predict whether a person decides to and actually takes preventive measures against mosquito bites. Knowing those factors that predispose and influence an individual's taking one or more preventive measures to avoid mosquito bites can enable public health prevention programs to be more effective in designing targeted educational and behavioral interventions. In the thematic context of the health behavior theories described earlier, the results from this survey suggest that certain knowledge, attitudes, beliefs, and perceptions regarding prevention of mosquito bites, and potential exposure to viruses that cause encephalitis, are reasonable predictors and antecedents to the acknowledgment of personal susceptibility and subsequent decisions to act to prevent mosquito bites.

These survey results suggest that three-quarters of the U.S. adult population has had experience with mosquitoes, mostly in their own state. However, less than half

expressed being somewhat to very concerned about being bitten by mosquitoes.

Nonetheless, over two-thirds of respondents who had seen mosquitoes the previous summer took action to avoid being bitten. The most frequently cited behavior was the use of insect repellent on skin and clothes. Less than half of the respondents who took action stayed indoors during late afternoon or early evenings or wore long sleeves and long pants, practices that may be considered as restricting personal freedom of movement, both literally and physically. Of the 1750 respondents surveyed, only approximately one-third perceived as very effective the precautions of insect repellent use, staying indoors during late afternoon or early evenings, or wearing long sleeves and long pants as methods for preventing mosquito bites. The behavior to use insect repellents may be tempered by the belief expressed by slightly less than half the sample that it is "somewhat" or "very likely" that using insect repellent can make a person sick.

Although more than one-half the U.S. sample (57%) stated that they had heard about encephalitis, mostly through television, friends/family, newspapers and magazines, less than 20% had known anyone who had encephalitis. About four in 10 respondents stated they knew how someone gets encephalitis, with the vast majority stating that it was caused by mosquitoes. Given only one-third of respondents perceived that encephalitis was an extremely serious illness, and nine in 10 respondents believed their chances of ever getting encephalitis to be less than 50 on a 100 point scale, it is not surprising that there appear to be few strong knowledge, attitude, or sociodemographic and lifestyle predictors for taking action to prevent mosquito bites. This may reflect an

overall weak belief that the susceptibility to harm from mosquito bites was not great enough, at the time of this survey, to warrant the adoption of preventive practices.

The observed levels of knowledge, attitudes, beliefs, and abilities of the U.S. adult population regarding mosquitoes and encephalitis do not appear strong enough, in terms of level and frequency, to suggest that U.S. adults demonstrated strong perceptions about being susceptible to mosquito-borne illness, that when combined with a weak perception of illness as sufficiently harmful to others or themselves, did not elicit the adoption of behaviors to prevent mosquito bites. This is not entirely unexpected given the risk reality for arboviral encephalitis in the U.S. was relatively low at the time of this survey.

However, U.S. adults' perceptions regarding the potential harm that mosquitoes can cause has probably changed dramatically since this study was conducted, given the introduction of West Nile virus (WNV) into North America, beginning in New York City in late 1999. The ensuing explosion of national and local media coverage following the WNV outbreak generated thousands of phone requests to the New York City Health Department (Fine A and Layton M 1999) and thousands of email requests to the CDC for information on the prevention of WNV (Centers for Disease Control and Prevention 1999f). The social amplification of WNV has most likely changed U.S. perceptions regarding mosquito-borne illnesses, particularly among persons living in the eastern U.S. (Kasperson RE and Kasperson JX 1996). However, this assumption has yet to be validated.

There were 17 independent variables considered across the three sample groups. Twelve of these variables (71%) were statistically significant ($p < 0.05$) in predicting one or more of the six behavioral variables. As a summary measure, the mosquito-bite prevention index measure appeared to be sensitive to 4 of the 12 independent variables (33%) that were statistically significant in predicting one or more of the six dependent variables. The independent variables that the mosquito bite prevention index measure failed to mirror were: respondent knowing how someone gets encephalitis, belief that encephalitis is a somewhat to extremely serious illness, belief that using insect repellent is somewhat to very effective, belief that staying indoors during late afternoon and evening was somewhat to very effective, perception of the likelihood of ever getting encephalitis, type of home, location where respondent lived, race and sex of respondent, all of which were statistically or marginally statistically significant predictors for one or more of the six behavioral dependent variables. Thus, the mosquito bite prevention index appears to be a relatively weak summary measure of the six behavioral dependent variables considered in this survey.

In summary, an attempt has been made to measure, from a behavioral epidemiological perspective, levels of knowledge, attitudes, perceptions of severity and susceptibility to mosquitoes and arboviral encephalitis, as well as those perceptions about the effectiveness of recommended preventive behaviors that may affect the likelihood of an individual adopting precautions to prevent mosquito bites. This baseline knowledge can serve to enable prevention programs to more effectively design and

target educational and behavioral interventions for the at-risk and not at-risk public regarding mosquito-borne illnesses in the U.S., such as St. Louis encephalitis, Lacrosse encephalitis, West Nile viral encephalitis, and dengue fever.

As with any random-digit-dialed telephone survey, there are acknowledged limitations to this study. Relying on self-reported data obtained through telephone interviewing methods does not allow the interviewer to validate respondents' answers. Social desirability could also result in bias in reporting sociodemographic and lifestyle characteristics. Further, the intrusive nature of telemarketing may deter some respondents from participating, even after being re-contacted by a refusal conversion specialist (Kristal A et al. 1993). Methods for independent validation should be explored, such as through qualitative techniques (Webb EJ et al. 1981; Patton MQ 1990; Patton MQ 1980). Moreover, potential selection bias may have been introduced given only respondents with telephones were interviewed, thus excluding approximately 5.1% of households that do not have a telephone in the home (U.S. Department of Commerce 1999), such as those that might be economically disadvantaged and minority populations.

Figure 1 goes here

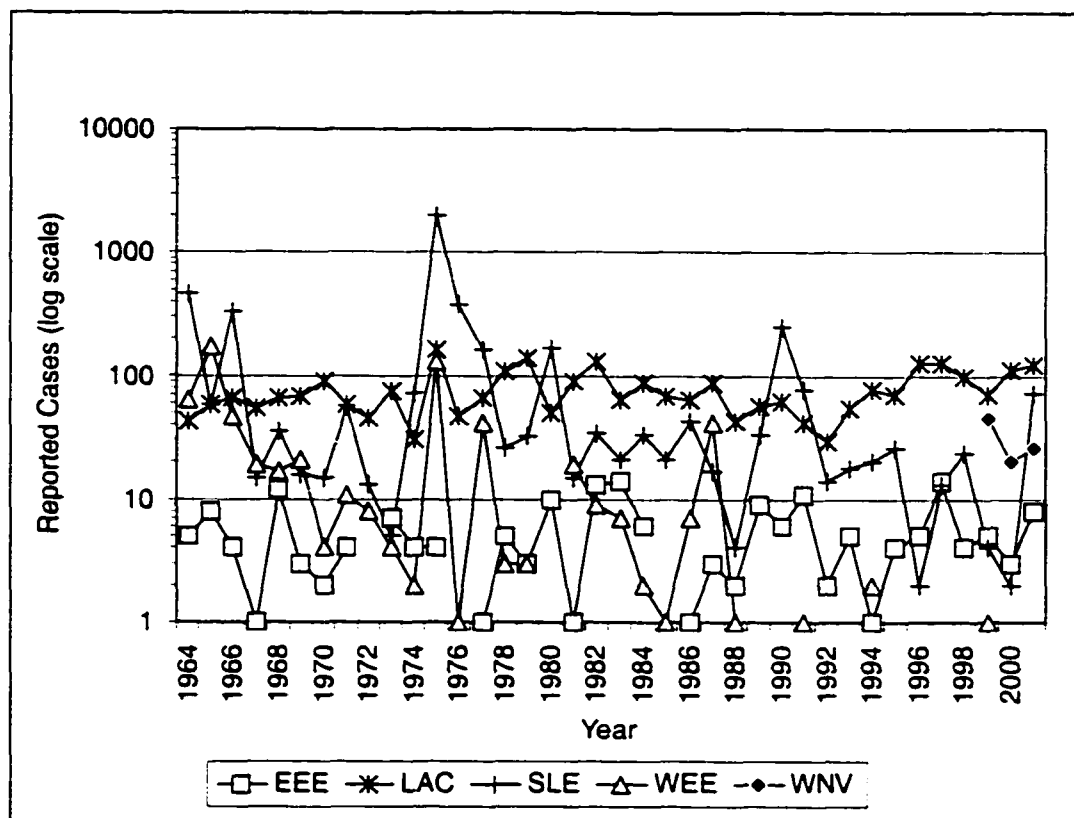


Figure 1. Reported cases of eastern equine encephalitis (EEE), Lacrosse encephalitis (LAC), St. Louis encephalitis (SLE), Western equine encephalitis (WEE), and West Nile virus (WNV), United States, 1964-2001 (Centers for Disease Control and Prevention 1998g; Centers for Disease Control and Prevention 1998e; Centers for Disease Control and Prevention 1998d; Centers for Disease Control and Prevention 1998f; Monath TP 1989) [Note: Data for 2001 are preliminary].

Table 1 goes here

Table 1. Frequencies regarding knowledge, attitudes, and practices regarding mosquitoes and encephalitis by sample.			
Variable	Number (%)		
	U.S. (n=1750) ^j	U.S. excluding six NE states (n=1247) ^k	NE states (n=503) ^l
Saw mosquitoes last summer	1341 (76.8)	969 (77.9)	364 (72.3)
In respondent's state	965 (71.9)	699 (72.1)	257 (70.6)
Somewhat to very concerned to be bitten by mosquitoes	576 (43.0)	417 (43.1)	151 (41.8)
Did anything to avoid mosquitoes	922 (68.8)	682 (70.6)	224 (61.7)
Used repellent to avoid bites	742 (80.5)	547 (80.2)	185 (82.5)
Used repellent on skin	679 (91.4)	501 (91.7)	166 (90.0)
Often on skin	177 (26.1)	135 (27.0)	33 (20.0)
Used repellent on clothes	437 (58.9)	327 (59.8)	103 (55.7)
Often on clothes	118 (27.1)	91 (27.8)	22 (21.3)
Stayed indoors late afternoon and evenings	386 (41.9)	289 (42.5)	85 (38.2)
Often stayed indoors	184 (47.6)	142 (49.2)	31 (36.0)
Wore long sleeves and pants	383 (41.6)	289 (42.4)	85 (38.1)
Often wore long sleeves and pants	177 (46.4)	135 (46.9)	34 (39.6)
Did anything else to avoid mosquitoes	251 (27.5)	183 (26.9)	62 (28.5)
Using insect repellent is somewhat to very effective	1479 (84.5)	1058(84.8)	420 (83.4)
Staying indoors in late afternoon and evening is somewhat to very effective	1358 (77.6)	977 (78.3)	370 (73.5)

^jCases weighted by WT.

^kCases weighted by NEWT.

^lCased weighted by NEWT.

Wearing long pants/sleeves is somewhat to very effective	1393 (79.6)	994 (79.7)	398 (79.1)
It is somewhat to very likely that using insect repellent can make you sick	735 (45.2)	517 (44.4)	222 (48.2)
It is somewhat to very likely that using insect repellent can make your children sick (asked of respondents with children)	317 (56.2)	213 (54.2)	114 (63.8)
Repellent used contain the chemical DEET			
Yes	125 (15.8)	90 (15.6)	38 (19.0)
No	147 (18.6)	107 (18.5)	37 (18.2)
Don't know/Not sure	516 (65.5)	381 (65.9)	126 (62.7)
Has heard about encephalitis	992 (56.7)	709 (57.2)	286 (56.9)
From where have you heard the most?			
TV	344 (34.6)	251 (35.4)	94 (32.9)
Radio	11 (1.1)	8 (1.2)	4 (1.3)
Newspapers	154 (15.6)	107 (15.1)	50 (17.6)
Magazines	132 (13.3)	90 (12.8)	38 (13.5)
Doctors	81 (8.2)	62 (8.7)	15 (5.3)
Somewhere else	224 (22.6)	160 (22.6)	66 (23.2)
Knows someone who has had encephalitis	154 (15.6)	111 (15.7)	44 (15.3)
Knows how someone gets encephalitis	438 (44.1)	320 (45.2)	115 (40.3)
Encephalitis is extremely serious illness	348 (35.1)	240 (33.9)	113 (39.5)
Encephalitis is extremely serious illness for your children (asked of respondents with children)	141 (51.9)	100 (51.5)	42 (52.9)

On scale 0=never and 100=definitely, likelihood respondent will ever get encephalitis:			
0-50	824 (94.2)	588 (93.4)	240 (97.6)
51-100	51 (5.8)	41 (6.6)	6 (2.4)
On scale 0=never and 100=definitely, likelihood respondent's children will ever get encephalitis:			
0-50	218 (90.0)	159 (90.2)	58 (88.6)
51-100	24 (10.0)	17 (9.8)	7 (11.4)

Table 2 goes here

Table 2. Crude odds ratios between self-reported behavior to prevent mosquito bites variable and selected variables, United States, 1998.						
Variable	U.S. (n=1750) ¹		U.S. excluding LD states (n=1247) ²		LD states (n=503) ²	
	N (%)	OR (95% CI) ³	N (%)	OR (95% CI)	N (%)	OR (95% CI)
Saw mosquitoes last summer in own state and elsewhere:						
Yes	834 (90.7)	1.34 (0.92, 1.93)*	619 (91.0)	1.44 (0.93, 2.24)*	198 (88.4)	0.99 (0.51, 1.92)
No	86 (9.3)		61 (9.0)		26 (11.6)	
Somewhat to very concerned to be bitten by mosquitoes:						
Yes	501 (54.3)	5.35 (4.03, 7.09)****	363 (53.2)	4.92 (3.52, 6.87)****	131 (58.5)	8.31 (4.83, 14.31)****
No	421 (45.7)		319 (46.8)		93 (41.5)	
Using insect repellent is somewhat to very effective:						
Yes	829 (92.5)	2.01 (1.38, 2.94)****	618 (93.2)	2.34 (1.48, 3.69)****	196 (89.5)	1.33 (0.69, 2.58)
No	67 (7.5)		45 (6.8)		23 (10.5)	
Staying indoors in late afternoon and evening somewhat to very effective:						
Yes	776 (86.0)	1.95 (1.45, 2.62)****	579 (86.9)	2.02 (1.41, 2.89)****	178 (80.2)	1.57 (0.95, 2.58)*
No	126 (14.0)		87 (13.1)		44 (19.8)	
Wearing long pants/sleeves somewhat to very effective:						
Yes	740 (80.8)	0.86 (0.64, 1.17)	584 (80.8)	0.91 (0.64, 1.31)	178 (80.2)	0.65 (0.36, 1.16)*
No	176 (19.2)		130 (19.2)		44 (19.8)	
It is somewhat to very likely that using insect repellent can make you sick:						
Yes	402 (45.9)	1.23 (0.97, 1.57)*	291 (44.9)	1.29 (0.91, 1.63)*	106 (50.5)	1.42 (0.91, 2.20)*
No	473 (54.1)		357 (51.1)		104 (49.5)	
It is somewhat to very likely that using insect repellent can make children sick (asked of respondents with children):						
Yes	201 (57.9)	0.97 (0.65, 1.46)	142 (56.6)	0.91 (0.56, 1.48)	58 (63.7)	1.42 (0.69, 2.91)
No	146 (42.1)		109 (43.4)		33 (36.3)	
Repellent used contained the chemical DEET						
Yes	120 (16.0)	0.72 (0.26, 1.97)	89 (16.1)	2.68 (0.35, 20.64)	32 (17.3)	0.25 (0.07, 0.87)**
No	631 (84.0)		465 (83.9)		153 (82.7)	
Has heard about encephalitis:						
Yes	549 (59.8)	1.27 (1.01, 1.61)**	401 (59.1)	1.28 (0.97, 1.69)*	148 (66.4)	1.46 (0.94, 2.25)*
No	369 (40.2)		278 (40.9)		75 (33.6)	
Knows someone who has had encephalitis:						
Yes	84 (15.4)	0.93 (2.061, 1.43)	61 (15.3)	0.94 (0.56, 1.57)	25 (16.8)	1.14 (0.54, 2.42)
No	463 (84.6)		338 (84.7)		124 (83.2)	
Knows how someone gets encephalitis:						
Yes	248 (45.1)	0.99 (0.73, 1.36)**	185 (46.3)	0.59 (0.22, 1.58)**	59 (39.9)	0.63 (0.57, 1.58)
No	302 (54.9)		215 (53.8)		89 (60.1)	

Variable	U.S. (n=1750) ¹		U.S. excluding LD states (n=1247) ²		LD states (n=503) ²	
	N (%)	OR (95% CI) ¹	N (%)	OR (95% CI)	N (%)	OR (95% CI)
Encephalitis is a somewhat to extremely serious illness: Yes No	432 (87.3) 63 (12.7)	1.66 (1.07, 2.58)	315 (87.3) 46 (12.7)	1.78 (1.05, 3.00)	118 (88.1) 16 (11.9)	1.35 (0.59, 3.10)
Encephalitis is extremely serious illness for your children (asked of respondents with children): Yes No	164 (93.7) 11 (6.3)	1.24 (0.33, 4.77)	120 (93.8) 8 (6.3)	1.25 (0.25, 6.26)	43 (93.5) 3 (6.5)	1.10 (0.11, 11.52)
On scale 0=never and 100=definitely, likelihood respondent will ever get encephalitis: 0-50 51-100	454 (94.6) 26 (5.4)	0.55 (0.22, 1.35)*	332 (93.8) 22 (6.2)	0.58 (0.22, 1.58)	122 (99.2) 1 (0.8)	0.63 (0.37, 0.71)
On scale 0=never and 100=definitely, likelihood respondent's children will ever get encephalitis: 0-50 51-100	156 (88.6) 20 (11.4)	0.67 (0.16, 2.01)	114 (88.4) 15 (11.6)	0.52 (0.11, 2.42)	41 (89.1) 5 (10.9)	0.77 (0.67, 0.90)
Reads newspaper four or more days per week: Yes No	443 (70.8) 183 (29.2)	0.70 (0.51, 0.97)**	325 (70.2) 138 (29.8)	0.67 (0.46, 1.00)*	37 (23.7) 156 (100)	0.92 (0.52, 1.63)
R has only dogs as pets: Yes No	260 (42.3) 356 (57.7)	1.49 (1.11, 1.20)***	196 (43.2) 258 (56.8)	1.50 (1.06, 2.12)**	56 (37.3) 84 (62.7)	1.35 (0.80, 2.27)
R has only cats as pets: Yes No	131 (27.0) 355 (73.0)	1.61 (1.10, 2.35)**	88 (17.3) 258 (74.6)	1.41 (0.89, 2.22)*	50 (34.7) 94 (65.3)	2.93 (1.51, 5.69)***
R has dogs and cats: Yes No	174 (32.9) 355 (57.1)	1.45 (1.04, 2.01)**	140 (35.2) 258 (64.8)	1.40 (0.96, 2.06)	22 (19.0) 94 (81.0)	1.29 (0.62, 2.68)
R has been to Asia/Africa/South America: Yes No	141 (15.3) 779 (84.7)	0.83 (0.61, 1.13)	103 (15.1) 578 (84.9)	0.79 (0.55, 1.14)*	36 (16.2) 186 (83.8)	1.03 (0.58, 1.84)
Employment status: Full time Part time/Not employed	651 (72.4) 248 (27.6)	1.06 (0.82, 1.38)	487 (73.5) 176 (26.5)	1.05 (0.77, 1.44)	148 (57.0) 73 (33.0)	1.05 (0.67, 1.64)
Marital status: Married Other	594 (66.3) 302 (33.7)	1.65 (1.30, 2.10)****	439 (66.4) 222 (33.6)	1.69 (1.27, 2.25)****	140 (63.9) 79 (36.1)	1.36 (0.88, 2.12)*
Type of home: Single house Other	675 (75.5) 219 (24.5)	1.39 (1.07, 1.80)*	514 (77.6) 148 (22.4)	1.55 (1.13, 2.12)**	138 (63.9) 78 (36.1)	0.81 (0.51, 1.29)

Variable	U.S. (n=1750) ¹		U.S. excluding LD states (n=1247) ²		LD states (n=503) ²	
	N (%)	OR (95% CI) ¹	N (%)	OR (95% CI)	N (%)	OR (95% CI)
Location where R lives: city suburb	274 (54.4) 230 (45.6)	0.96 (0.71, 1.31)	212 (57.5) 157 (42.5)	1.02 (0.70, 1.48)	53 (40.5) 78 (59.5)	0.80 (0.46, 1.38)
Location where R lives: city small town	274 (58.3) 196 (41.7)	0.80 (0.58, 1.13)*	212 (69.7) 143 (40.3)	0.90 (0.58, 1.29)	53 (52.0) 49 (48.0)	0.59 (0.31, 1.14)*
Location where R lives: city rural area	274 (57.9) 199 (42.1)	0.87 (0.62, 1.20)	212 (58.1) 153 (41.9)	0.88 (0.60, 1.30)	53 (58.2) 38 (41.8)	0.98 (0.52, 1.85)
Location where R lives: suburb small town	230 (54.0) 196 (46.0)	0.85 (0.59, 1.19)	157 (52.3) 143 (47.7)	0.85 (0.56, 1.29)	78 (61.4) 49 (38.6)	0.74 (0.40, 1.38)
Location where R lives: suburb rural area	230 (53.6) 199 (46.4)	0.91 (0.64, 1.27)	157 (50.6) 153 (49.4)	0.87 (0.58, 1.31)	79 (67.2) 38 (32.8)	1.22 (0.67, 2.24)
Location where R lives: small town rural area	196 (49.6) 199 (50.4)	1.07 (0.74, 1.55)	143 (48.3) 153 (51.7)	1.20 (0.66, 1.57)	49 (56.3) 38 (43.7)	1.64 (0.81, 3.31)*
Years R has lived at current residence: ≤ 10 years 11 years +	672 (82) 148 (18)	1.09 (0.79, 1.49)	502 (83.0) 103 (17.0)	1.12 (0.76, 1.64)	156 (77.2) 46 (22.8)	0.99 (0.58, 1.69)
R's family is covered by health insurance: Yes No	729 (87.0) 109 (13.0)	1.03 (0.71, 1.49)	540 (87.2) 79 (12.8)	0.92 (0.58, 1.46)	173 (85.2) 30 (14.8)	1.19 (0.64, 2.21)
Respondent's age: 18 to 44 45 and older	539 (60.8) 347 (39.2)	1.11 (0.88, 1.42)	400 (60.9) 257 (39.1)	1.08 (0.81, 1.43)	128 (60.4) 84 (39.6)	1.28 (0.82, 2.00)
Respondent's race: White Other	772 (85.7) 129 (14.3)	1.01 (0.72, 1.41)	569 (85.6) 96 (14.4)	1.07 (0.73, 1.59)	191 (86.8) 29 (13.2)	0.81 (0.42, 1.57)
Respondent's level of education: ≤ high school > some college	429 (47.1) 482 (52.9)	0.81 (0.64, 1.03)*	315 (46.7) 360 (53.3)	0.75 (0.56, 0.99)**	109 (49.5) 111 (50.5)	1.14 (0.75, 1.78)
Household income: ≤ \$50,000 >\$50,001	364 (51.6) 341 (48.4)	0.84 (0.64, 1.10)*	276 (53.2) 243 (46.8)	0.84 (0.61, 1.18)	76 (42.9) 101 (57.1)	0.74 (0.45, 1.21)
Respondent's sex: Female Male	407 (44.1) 515 (55.9)	0.60 (0.48, 0.76)****	309 (45.3) 373 (54.7)	0.92 (0.58, 1.46)	96 (42.9) 128 (57.1)	1.19 (0.64, 2.21)

1. OR = crude odd ratio and 95% confidence interval; cases weighted by WT.
2. Cases weighted by NEWT.

*P<0.25, **P<0.05, ***P<0.01, ****P<0.001

Table 3 goes here

Predictor variables	Sample ^a	Individual Behaviors (OR, 95% CI) ^b							
		Used repellent to avoid bites	Used repellent on skin	Used repellent on clothes	Stayed indoors late afternoon and evenings	Wore long sleeves and long pants	Did anything else to avoid mosquitoes	Mosquito Bite Prevention Index Measure ^c	
R ¹ knows how someone gets encephalitis (Y/N)	I					0.66 (0.45, 0.97)*			
	II					0.64 (0.41, 0.99)*			
	III								
R believes encephalitis is somewhat to extremely serious illness (Y/N)	I	3.56 (2.40, 5.28)**	3.29 (2.24, 4.83)**	3.11 (2.13, 4.54)**	3.58 (2.42, 5.30)**	3.52 (2.39, 5.18)**	2.46 (1.61, 3.75)**	7.26 (4.31, 12.23)**	
	II	3.10 (1.95, 4.94)**	2.93 (1.87, 4.60)**	2.85 (1.83, 4.45)**	3.38 (2.13, 5.36)**	3.14 (2.00, 4.93)**	2.58 (1.57, 4.24)**	6.38 (3.45, 11.79)**	
	III	10.18 (4.03, 25.74)**	7.76 (3.19, 18.88)**	4.16 (1.84, 9.38)**	7.22 (2.66, 19.63)**	6.13 (2.50, 15.04)**		20.21 (6.14, 66.51)**	
R believes using insect repellent is somewhat to very effective (Y/N)	I								
	II								
	III								
R believes staying indoors in late afternoon and evening is somewhat to very effective (Y/N)	I								
	II								
	III								
R believes wearing long pants/sleeves is somewhat to very effective (Y/N)	I								
	II								
	III								
R believes insect repellent will make you sick (N/Y)	I	1.45 (1.00, 2.12)*	1.67 (1.15, 2.43)**		0.66 (0.44, 0.97)*	0.68 (0.47, 1.00)*		0.40 (0.21, 0.77)**	
	II	1.62 (1.04, 2.52)*	1.82 (1.17, 2.83)**		0.62 (0.39, 0.98)*			0.42 (0.19, 0.95)**	
	III	0.16 (0.05, 0.52)**	0.19 (0.06, 0.59)**		0.13 (0.04, 0.45)**			0.15 (0.04, 0.53)**	
R has dogs and/or cats as pets (Y/N)	I	1.43 (0.98, 2.06)*		1.59 (1.10, 2.33)**				0.33 (0.11, 0.88)*	
	II			1.68 (1.07, 2.61)**				1.58 (1.02, 2.44)*	
	III		2.84 (1.23, 6.55)**					1.94 (1.14, 3.28)**	

Individual Behaviors (OR, 95% CI)¹

Table 3. Logistic regression analysis predicting an index measure and several self-reported behaviors to prevent mosquito bites, United States, 1998

Predictor variables	Sample ²	Used repellent to avoid bites	Used repellent on skin	Used repellent on clothes	Stayed indoors late afternoon and evenings	Wore long sleeves and long pants	Did anything else to avoid mosquitoes	Mosquito Bite Prevention Index Measure ³
R is married (Y/N)	I	2.07 (1.37, 3.14)**	1.80 (1.19, 2.70)**					2.81 (1.75, 4.50)**
	II	2.38 (1.34, 3.53)**	1.89 (1.17, 3.06)**	1.64 (1.00, 2.67)*				3.08 (1.77, 5.35)**
R lives in city/suburb (Y/N)	I	1.51 (1.04, 2.19)*	1.61 (1.11, 2.32)**	1.49 (1.03, 2.16)*				
	II	1.66 (1.06, 2.59)*	1.64 (1.06, 2.54)*					
R is 18-44 (Y/N)	I		2.04 (1.41, 2.97)**	1.90 (1.30, 2.77)**	0.63 (0.42, 0.93)*			
	II	1.66 (1.06, 2.58)*	1.76 (1.13, 2.72)*	1.80 (1.16, 2.80)**	0.62 (0.39, 0.98)*			
	III	3.69 (1.54, 8.84)**	6.08 (2.55, 14.50)**	2.39 (1.09, 5.20)*				3.17 (1.20, 8.36)*
R is White (Y/N)	I	1.83 (1.25, 2.67)**						
	II							0.62 (0.39, 1.00)*

1 OR = adjusted odds ratio, CI=confidence interval

2 I = U.S. sample, cases weighted by WT, II = U.S. sample excluding Connecticut, Delaware, New Jersey, New York, Pennsylvania, and Rhode Island, cases weighted by NEWT, III = Over-sampled states of Connecticut, Delaware, New Jersey, New York, Pennsylvania, and Rhode Island, cases weighted by NEWT

3 The index measure for the prevention of mosquito bites equals the sum of six behavioral variables (where respondent stated they had performed the action coded yes = 1 and no = 0) plus the sum of four frequency of action variables (where respondent stated they had performed the action "sometimes or often vs. occasionally," coded 1 and 0 respectively) that yielded an action score (range 0 to 10). The index measure was dichotomized and coded such that "action" equaled scores greater than or equal to 1 and no action equaled scores of 0

§R = respondent

*p<0.05, **p<0.01, ***p<0.001, non-significant data not shown

CHAPTER 6

Discussion and Conclusions

The literature offers relatively few studies with empirical data on public knowledge, attitudes, practices, and risk perceptions regarding personal susceptibility and disease severity regarding ticks and Lyme disease in the United States (Herrington JE et al. 1997; Hallman W et al. 1995; Schwartz BS and Goldstein MD 1990; Brown SW et al. 1992; Cartter ML et al. 1989; Taylor GC 1991; Shadick NA et al. 1997). There appears to be no such published data on the above factors regarding mosquitoes and arboviral encephalitis in the continental United States, although some ethnographic and sociomedical studies have been published regarding attempts to prevent dengue fever and DHF in Puerto Rico (Gubler DJ 1989; Gubler DJ and Clark GG 1994), Mexico (Lloyd LS et al. 1994; Winch P et al. 1991; Lloyd LS et al. 1992), and internationally (Winch P 1998).

Concerning ticks and Lyme disease, a cross-sectional study conducted in 1988 examined the prevalence of risk factors for antibody seropositivity to B. burgdorferi in outdoor workers in New Jersey (n= 689) (Schwartz BS and Goldstein MD 1990). After adjustment for multiple confounding variables with logistic regression, the researchers reported a significant association between being an outdoor worker and occupational risk for tick exposure (OR = 5.1; 95% CI = 1.1, 23.6). Further, this

study reported that any use of insect repellent or antibiotics may have decreased the risk of Lyme disease in outdoor workers given the adjusted odds ratios for not using insect repellent or antibiotics was 2.0 (95% CI = 1.0, 4.0) and 2.3 (95% CI = 0.8, 6.7), respectively. The authors concluded that Lyme disease was a hazard of outdoor work and that increased recognition of this fact would be necessary to prevent Lyme disease in outdoor workers. Attitudes and perceptions of susceptibility and disease severity were not reported by the authors.

A study in 1992 of 178 adult visitors to recreational parks located in Lyme disease endemic counties in New Jersey found that 83% of respondents could name at least one tick bite prevention measure, but only 43% reported taking any precautions (Hallman W et al. 1995). Precaution taking was found to be significantly associated with having known someone who had Lyme disease and believing that the illness was difficult to treat. Dissonance between reported levels of knowledge regarding ticks and Lyme disease and the adoption of tick bite prevention practices have been reported among Connecticut residents (Brown SW et al. 1992) and high school students in Connecticut (Cartter ML et al. 1989).

A convenience survey of ferry passengers traveling to/from Martha's Vineyard and the Massachusetts mainland (n=304) found that although respondents demonstrated very good knowledge of Lyme disease, with 73% correctly answering items on a knowledge test, only 59% reported scaling back time spent in tick-infested areas, 58% reported wearing protective clothing, 40% reported using an insect

repellent, and 66% reported performing tick checks (Shadick NA et al. 1997). The authors concluded that, despite evidence of high knowledge regarding ticks and Lyme disease, personal protective behaviors were underperformed. Instead, performance appeared to be related to self-efficacy in being able to find a tick on oneself and the perception that the protective behavior's benefits outweighed the behavior's inconvenience and would serve to effectively reduce the risk of getting Lyme disease. Hence, focus on increasing general knowledge appeared insufficient in increasing the adoption of protective behaviors. Rather, prevention programs should concentrate on building and enhancing skills to recognize and appropriately remove ticks when they are found on oneself (Shadick NA et al. 1997).

A large cross-sectional study in 1995 surveyed 4246 persons in three states, Connecticut being endemic for Lyme disease, Maine where Lyme disease incidence is considered marginal and emerging, and Montana where the tick vectors and bacterial agent *B. burgdorferi* were not known to be present (Herrington JE et al. 1997).

Adjusted odds ratios found that knowing anyone with Lyme disease (Connecticut: OR = 2.1; 95% CI = 1.6, 2.8; Maine and Montana were not significant), high knowledge about Lyme disease (Connecticut: OR = 1.6; 95% CI = 1.2, 2.2; Maine: OR = 1.7; 95% CI = 1.2, 2.5; Montana was not significant), and perceiving a medium to high risk for getting Lyme disease (Connecticut: OR = 1.9; 95% CI = 1.4, 2.5; Maine: OR = 2.6; 95% CI = 1.7, 4.1; Montana: OR = 2.0; 95% CI = 1.2, 3.4) were significantly associated with self-reported tick bite prevention practices. The perception of a

moderate to high risk for acquiring Lyme disease by Montanans surveyed may have been an artifact reflecting respondents' concern about tick-borne diseases in general, including Rocky Mountain spotted fever, tick paralysis, and Colorado tick fever, as well as Lyme disease (Herrington JE et al. 1997).

HIV prevention and the BRFSS have demonstrated that public health prevention programs can be designed based on a more thorough understanding of the psychological, behavioral, educational, sociodemographic, and other salient factors that may motivate individuals to adopt precautions against a health hazard (Centers for Disease Control and Prevention 1995b; Valdiserri RO, Holtgrave DR, and Brackbill RM 1993; Centers for Disease Control and Prevention 1999e; Carter ML et al. 1989).

What did we learn from this study? Not surprisingly, over 86% of U.S. adults had heard about Lyme disease. However, only 40% reported doing anything to avoid being bitten by ticks. Less than half of this group (41%) reported using insect repellent. Tick removal using tweezers was reported by about 40% of U.S. respondents. However, nearly 30% stated they used other methods which included putting alcohol, nail polish remover, oil, or similar products on the embedded tick (35%), pulling the tick out with one's fingers (32%), or seeking medical care at a doctor's office, hospital, or emergency room (11%). Consistent with the Martha's Vineyard ferry study described above, prevention messages may need to focus more on building and sustaining an individual's skills to appropriately remove ticks, particularly in areas where

the at-risk population has relatively high levels of knowledge about Lyme disease and its transmission.

Respondents' perception of susceptibility to Lyme disease was low. Of those who had heard about Lyme disease, 92% stated their likelihood of ever getting the disease was 50 or less on a 100 point scale (\bar{x} = 29), where 0 = never and 100 = definitely. This finding of a lack of susceptibility to Lyme disease was similar for the U.S. sample, the non-Lyme disease states sample, as well as for the six Lyme disease states. It is unexpected that this latter group would perceive low vulnerability to Lyme disease, given more than 90% of reported cases of Lyme disease occurred in these six states (Connecticut, Delaware, New Jersey, New York, Pennsylvania, and Rhode Island) at the time of this study. Further, with adjustment for confounding factors, U.S. respondents and those from the non-Lyme disease states who believed their risk of getting Lyme disease was high (>50 on the 0 to 100 scale) indicated they used insect repellent to prevent tick bites. By contrast, perceptions of susceptibility to Lyme disease was not a significant predictor for the use of insect repellent for respondents from the six Lyme disease states. One interpretation of the lack of perceived susceptibility by respondents from the six Lyme disease states is that prevention messages in this region of the nation have been effective in informing respondents of the risks of infection and measures to prevent tick bites. Hence, the response by residents of the six Lyme disease states, rather than be driven by dread of the unknown, may be a response based on adequate knowledge of and experience with ticks and Lyme

disease, a finding that is supported by risk perception theorists who posit that dread and vulnerability are inversely related to knowledge and experience with a hazard (Slovic P 1987; Wildavsky A and Drake K 1990; O'Riordan T 1995). In this context, it was reasonable and expected to observe that being somewhat to very concerned about being bitten by ticks was strongly associated with taking preventive measures (OR = 8.34; 95% CI = 6.29, 11.06), particularly given the consistent increase in Lyme disease incidence in the Northeastern states (Centers for Disease Control and Prevention 2002). Logistic regression analyses, in adjusting for multiple confounding variables, demonstrated that having seen ticks the previous summer, being concerned about being bitten, believing insect repellent was an effective method, having heard about Lyme disease, and knowing someone who had Lyme disease were the factors that best predicted specific preventive measures to avoid tick-bites ($p < 0.001$).

Regarding mosquitoes and encephalitis, this study establishes a previously unknown baseline measure on knowledge, attitudes, practices, and risk perceptions of U.S. adults. No published studies could be located through literature searches on Medline that were representative of and generalizable to the U.S. adult population regarding mosquitoes and arboviral encephalitis. Thus, this study makes a unique contribution to the general knowledge of mosquito-borne infectious disease.

What did we learn about the U.S. adult's perception of mosquitoes and arboviral encephalitis? Over 75% of the 1750 respondents surveyed had seen mosquitoes the previous summer and 68% had done something to avoid being bitten.

Of this latter group, about 80% reported using insect repellent, 42% said they stayed indoors in late afternoon/early evening, and 42% stated they wore long sleeves and long pants. About one-third of those respondents who had taken preventive measures believed that insect repellent was very effective in preventing mosquito bites. Use of insect repellent on skin and clothes was the most frequently cited behavior for preventing mosquito bites. By contrast, the remaining two-thirds perceived as little or not at all effective the precautions of insect repellent use, staying indoors during late afternoon or early evenings, or wearing long sleeves and long pants as methods for preventing mosquito bites. Furthermore, there appears to be perceived susceptibility to becoming ill from using an insect repellent. Slightly less than half the U.S. sample believed it was somewhat to very likely that using an insect repellent could make an individual sick. This perception may temper the behavior of actually using an insect repellent to prevent mosquito bites.

If individuals are not practicing the recommended behaviors for preventing mosquito bites, what else are they doing? Of the 922 respondents who stated they did anything to avoid mosquito bites, 72% indicated they also used other methods. Most frequently cited in these open-ended responses were burning/using citronella candles, (Jensen T et al. 2000; Lindsay LR et al. 1996; Matsuda BM et al. 1996) spraying insecticide, emptying/draining water sites, and using Avon Skin-So-Soft™, a bath oil (Lindsay RL, Heal JD, and Surgeoner GA 1996).

Encephalitis was not unknown to U.S. adults, given 57% of respondents stated

that they had heard about it through television, friends/family, newspapers and magazines. However, only one in five persons had known anyone who had had encephalitis. About four in ten respondents stated they knew how someone gets encephalitis, with the vast majority stating that it was caused by mosquitoes. Given that only one-third of respondents perceived that encephalitis was an extremely serious illness and that only 6% of respondents believed their chances of ever getting encephalitis were greater than 50 on a 100 point scale, it is not surprising that there appears to be few strong knowledge, attitude, or sociodemographic and lifestyle predictors for taking action to prevent mosquito bites. This weak perception of susceptibility to harm from mosquito bites was apparently not strong enough to warrant the adoption of precautions by many U.S. adults. In conclusion, and not entirely unexpected, given the risk reality for arboviral encephalitis in the U.S., perceptions of risk among the U.S. population were relatively low at the time of this survey.

However, why did some people and not others take action to prevent mosquito bites? Among respondents who reported taking action, those that expressed the perception of being somewhat to very concerned about being bitten by mosquitoes were five times more likely to take preventive measures when compared with respondents who were only a little or not at all concerned about being bitten (OR = 5.3; 95% CI = 4.0, 7.1). Thus, heightened concern appears to evoke a strong association with taking preventive action against both ticks and mosquitoes. Further operationalization of the term concern, to delineate and specify its meaning relative to

prevention of tick and mosquito bites may be useful to better craft prevention messages. For example, can concern be equated with fear, worry, dread, preoccupation, or apprehensiveness? As applied to a stage theory, such as the Precaution Adoption Process Model, concern appears to be delineated in terms of the risk a hazard may have on others (Stage 2) and the risk of a hazard affecting oneself (Stage 3). In this sense, a stage theory offers the utility of understanding with greater precision at what point in the decision making process of adopting a precaution against ticks or mosquitoes a targeted population may be, thus allowing the public health message developer to frame the prevention message in terms of the stages of adoption of the beneficiaries.

Other factors that appeared to be strong predictors of taking preventive action against mosquito bites were believing encephalitis was a somewhat to extremely serious illness, believing that insect repellent was somewhat to very effective, believing that staying indoors during late afternoon and evening was somewhat to very effective, and pet ownership ($p < 0.05$). In structuring prevention messages it would appear significant to reinforce the concepts that encephalitis is a serious disease (perceived severity), that insect repellent is effective (recommended prevention method), and that avoidance of mosquitoes by staying indoors in the late afternoon or early evenings is also effective (recommended prevention method). However, the other prevention methods that did not appear to influence preventive behavior should be revisited. Why is the recommendation to wear long sleeves and long pants not perceived to be an

effective method? Is the perception regarding insect repellent use on skin less or more acceptable than use on clothes? What are the issues surrounding the perceived toxicity of insect repellent that contains DEET? Are less effective repellent methods, such as citronella candles and Avon Skin-So-Soft™ bath oil, actually more frequently used than DEET containing repellents? If so, what are the public's perceptions regarding these products? As discussed below, future researchers might want to employ qualitative methods, such as interviewing key informants and using focus-group sessions in geographic areas where West Nile virus infections in humans and animals have been reported, to tease out and add clarity to the components and details of these perceptions.

With the outbreak and emergence of West Nile virus into North America, beginning in New York City in late 1999, U.S. adults' perceptions regarding the severity and susceptibility of mosquito-borne illness has probably changed dramatically. The explosion of local and national media coverage following the West Nile virus outbreak generated thousands of phone requests to the New York City Health Department (Fine A and Layton M 1999) and thousands of email requests to the CDC (Centers for Disease Control and Prevention 1999f) for information on the prevention of West Nile virus. The social amplification of West Nile virus has most likely changed U.S. perceptions regarding mosquito-borne illnesses, particularly among persons living in the eastern U.S.

This study identified and examined potential factors that could influence and

motivate individuals to adopt measures to prevent personal infection from agents transmitted by ticks and mosquitoes, specifically the spirochete Borrelia burgdorferi that causes Lyme disease and the viruses that can cause arboviral encephalitis (i.e., Eastern equine, LaCrosse, St. Louis, West Nile, and Western equine encephalitis viruses). In the behavioral epidemiological context, this study has contributed to the basic understanding of those etiological factors, such as the precursors, motivators, and barriers to the adoption of healthy behaviors, that are relevant for the prevention of infections transmitted by ticks and mosquitoes. Behavioral epidemiology is a relatively new subset of the science of epidemiological inquiry. Similar to molecular epidemiology, which developed with the advent of molecular methods that directly examine the genotype or DNA specific to the pathogenic strain of an organism, such as drug-resistant Staphylococcus aureus (Drucker E 1993; Lupski JR 1993), behavioral epidemiology is developing as a science of inquiry that employs the psychological sciences and public health's central discipline, epidemiology, to examine the distribution of health-related behaviors in populations, the association of these behaviors with well-being, morbidity, and mortality, and attempts to discover techniques for changing, improving, predicting (Connors M and Norman P 1996) and sustaining healthy behaviors (Elder JP 2000). This study has contributed to behavioral epidemiology by examining, from a national perspective and in a subgroup of highly endemic states, the distribution of health-related behaviors in these populations and the associations of these behaviors with recommended methods for preventing tick-borne and mosquito-

borne infections.

Several suggestions are made for further research. First, the actual or “true” risk for Lyme disease and the arboviral encephalitides was only indirectly assessed by the current study in terms of comparing population groups by reported rates of disease, such as the northeastern states region compared with the remaining states in the continental U.S. But what is the actual risk for an individual getting bitten by a tick or mosquito? What are the factors that place an individual at risk for tick or mosquito bites? Can these factors be combined in some weighted fashion to provide an index for individual risk for tick or mosquito bites? Data sources for developing an individual risk measure might include the following: entomological surveys on vector(s) prevalence, infectivity of vector(s), seasons for high exposure (spring, summer), prevalence of reservoir hosts for vectors (deer, white-footed mice, birds, other?), geographic locations; and behavioral surveys that measure the specific actions that clinically diagnosed persons believe to have placed themselves at risk for exposure, such as type of activity (being outdoors in late afternoon early evening, hiking, gardening, brush clearing, other?), the frequency of risky activities (everyday, once per week, other?), and preventive behaviors reportedly used (insecticide use on skin, clothes, pets, yard, removal of larval production sites, protective clothing, avoidance, other?). These factors, when combined and weighted, could be assessed and tested as an accurate risk index (high, medium, low) for exposure to tick or mosquito bites. Assuming unlimited resources to conduct such a study, including monetary or in-kind means to

encourage participation, prospective research could be used to validate the risk indices by tracking the actual behaviors of cohorts of individuals across varying risk environments. Measurement methods could include individual pencil and paper diary logs, telephone or internet-based self-reporting interfaces, periodic in-person, telephone, or email contacts, mail-in daily or weekly diary response sheets, global positioning tracking devices that could be worn by a person (similar to a cell-phone clip-on unit) that would provide temporal and spatial data for an individual that could then be compared against environmental databases of known tick or mosquito habitats, or similar innovative qualitative techniques for recording human behavior in an attempt to directly measure actual or true risk for exposure to ticks or mosquitoes.

Second, the recommended precautions for the prevention of tick or mosquito bites in the present study are given equal weight, when in reality a given precaution may be more or less protective than another. Which individual method or combination of methods is most to least effective in preventing tick bites? Tucking pants into socks? Wearing light colored clothing? Using insect repellent on skin and/or clothes? Avoiding wooded or grassy areas? Similarly for the prevention of mosquito bites, which individual method or a combination thereof is more likely to offer protection to the user? Wearing long sleeves and long pants? Staying indoors late afternoon and early evening? Using insect repellent on skin and/or clothes? A researcher could ask a group of recognized experts to judge the relative effectiveness of the recommended precautions, including their expert opinion on how frequently a precaution should be

performed for maximum effectiveness, and then recalculate the tick bite and mosquito bite prevention indices, accordingly, based on assigned weights as judged by the panel of experts. Further, additional analyses of the indices of preventive measures could be done in non-binary fashion, such as using a continuous measure, a categorical variable with three or four levels, such as “none, low, medium, or high,” or both. The frequency with which a precaution is performed could also be factored into each variable, effectively giving greater weight to a precaution that is performed more frequently and less weight if performed with lower frequency. Such analyses, using a “weighted sum” index, could provide a more accurate and, perhaps, more robust index measure of the recommended precautions.

Alternatively, a researcher could examine the present data set using factor analytic techniques in order to group similar variables into a few significant “factors.” based on the correlations that may be present among a number of interrelated variables. The variables present within each “factor” would be more highly correlated with each other than variables that compose other “factors.” As a result, each factor could “represent” a meaning common to the cluster of variables that compose each factor, thereby allowing measurement, for example, of a respondent’s knowledge, perceived susceptibility of a hazard for others, perceived severity of a hazard for oneself, and perceived effectiveness of recommended behaviors, regarding ticks or mosquitoes. This reductionist approach allows many variables to be summarized by a few factors. Statistical programs can then be used to perform t tests, regression, analysis of

variance, or discriminate analysis based on input variables that are derived from scores computed for each factor (1999).

Third, the open-ended responses collected in the present study were categorized by the author and, therefore, reflect only the author's humble judgement. To validate the categorizations and reduce a potential source of systematic bias, a reliability assessment of the open-ended responses could be performed using the Delphi-technique (Jones J and Hunter D 1995) or similar consensus building exercises with a panel of vector-borne infectious disease experts. These techniques do not require the physical presence of the panel of experts, given paper scoring forms can be mailed or communicated electronically by e-mail. Basically, the open-ended responses are reviewed by the panelists and categories created. Agreement and disagreement among the panelists on the categories is addressed through a scoring technique that also includes a self-rating of confidence or certainty each panelist has in his/her own scoring. Further, the open-ended responses are reviewed by the panelists and grouped into consensus categories, again with a scoring technique that also includes a self-rating of panelist's confidence or certainty in his/her own scoring. The outcome of this process is a categorization of the open-ended responses that reflects the collective opinion of the panel of experts, thereby reducing the potential for systematic bias from having only one reviewer.

Fourth, the present study revealed a strong perception that DEET-containing insect repellents may be harmful to individuals, particularly children. This perception

appeared to moderate the use of DEET-containing repellent in favor of less effective products, such as Avon Skin-So-Soft™, a bath oil. Insect repellents that contain 30% DEET have been shown to be highly effective in preventing tick and mosquito bites (Jensen T et al. 2000; Lindsay RL, Heal JD, and Surgeoner GA 1996). DEET has a strong toxicological safety record when used according to manufacturer directions (Fradin MS 1998). However, some repellents are marketed as “DEET-free” (Smith IK 2001). Thus, to address the erroneous perceptions that DEET is harmful to humans and promote its use in preventing tick and mosquito bites, future research might use formative and focus-group techniques to identify positive, negative, and neutral factors an individual perceives about DEET, Avon Skin-So-Soft™, and other insect repellent products. Are perceptions consistent across age, education, ethnic, income, and geographic location of at-risk and non-at-risk groups? Channels of information (Maibach E and Parrott RL 1995; Rice RE and Atkin CK 1989; Salmon CT 1989) regarding DEET should also be explored, such as media (television, radio, internet, print), family members, peers, government, etc., the perceived levels of confidence (little, some, a lot, very much) an individual places in each information channel, and the frequency with which individuals access these channels for information about insect repellents. Are the messages individuals hear about DEET and other insect repellents consistent, mixed, or contradictory? Are the messages new or traditional? How do perceptions about DEET compare with perceptions about other pesticides, such as those used for agricultural products, flower or garden insects and pests, lawn

care herbicides, or rodenticides? In other words, is DEET lumped together under a general category of “pesticides” or is DEET perceived as a “niche product?” Is DEET poorly understood because of inconsistent information from U.S. federal government agencies, such as the Environmental Protection Agency, the Centers for Disease Control and Prevention, and the Food and Drug Administration? Qualitative research (Patton MQ 1990) to address the questions above could help to target an effective campaign that addresses the mixed perceptions about DEET-containing insect repellents observed in the present study.

Finally, the results of the present baseline study could serve as the basis for theory-grounded research that could significantly define and illustrate the barriers and motivators to the adoption of precautions against vector-borne infectious diseases. For example, using a stage theory approach, as advocated by the Precaution Adoption Process Model (Weinstein ND, Rothman A, and Sutton S 1998; Weinstein ND and Sandman PM (in press)), a researcher could focus on one precaution, such as the adoption of the precaution to use DEET-containing insect repellents. Assume the researcher is collaborating with a manufacturer of DEET-containing insect repellents. The manufacturer desires to introduce a newly formulated DEET-containing insect repellent called “SafeDEET.” The manufacturer wants to test market the new product among a geographically specific population at-risk for tick bites and potential infection from the bacterium that causes Lyme disease. Prior to launching the marketing campaign for “SafeDEET,” the researcher could survey the targeted population and

two comparable non-targeted populations using a survey instrument developed around the five stages of the Precaution Adoption Process Model. Recall that Stages 1 through 3 relate to beliefs about personal susceptibility to a health threat (“Has heard about the hazard,” “Believes others are at risk,” and “Believes self is at risk”) and stages 4 and 5 are associated with personal decision and action (“Decides to take action” and “Takes action”). Each individual stage is dichotomous, indicating that either the individual has reached that particular stage or not. The determinants that motivate a person into a given stage and from one stage to the next may be numerous, reflecting the differences that exist in individuals’ personal experience, belief origins, and perceptions of vulnerability to a given hazard. Thus, there is not necessarily a linear relationship between stages. Questions the researcher could ask of the target populations would focus on insects, insect repellents in general, alternatives to DEET, and DEET-formulated products in particular, based on results from preliminary formative and focus-group data. An advantage of using the Precaution Adoption Process Model is being able to track an individual’s decision-making progress from one stage to the next over time, given the researcher would re-contact the initial respondents (in all three groups) two or more times after some predetermined period (3 months, 6 months, 1 year, etc.). The information collected could form the basis for a communication and marketing plan that was systematically developed by analyzing the market, segmenting the target audience, strategizing about the four *P*s (product, promotion, placement, and price), and understanding the marketing channels, all

through the theory-based lens of the Precaution Adoption Process Model. While health communication and marketing techniques are essential to promoting a novel product or public health message (Maibach E and Parrott RL 1995; Rice RE and Atkin CK 1989; Salmon CT 1989), understanding the causal pathways by which the target audience adopts the behavior, in this case using “SafeDEET,” and retains the behavior, is essential to long-term success (Weinstein ND and Nicolich M (1992, unpublished manuscript); Weinstein ND, Rothman A, and Sutton S 1998). Thus, theory-based research, as suggested here, may provide significant insight into the motivators and barriers to adoption of the desired behavior and should be taken up by industrious and analytical students and practitioners.

There were three objectives for this study. First, the thematic areas common to theories of health behavior were used to develop a series of questions that would elicit levels of knowledge about a given hazard, the perceived severity of the hazard, the perceived susceptibility to the hazard for oneself and for others, and the perceived effectiveness of recommended measures to prevent exposure to the hazard (Janz NK and Becker MH 1984; Bandura A 1977; Ajzen I and Fishbein M 1980; Connors M and Norman P 1996; Weinstein ND 1993; Bandura A 1995; Ajzen I and Madden JT 1986; Green LW and Kreuter MW 1991). The questions selected were based on focus-group research and pretesting. Specifically, data were collected on the following: levels of knowledge and experience regarding ticks, Lyme disease, mosquitoes, and viral encephalitis; the perceived severity of Lyme disease and arboviral encephalitis; the

perceived susceptibility of being bitten by ticks or getting Lyme disease and being bitten by mosquitoes or getting arboviral encephalitis; the specific practices used to prevent tick and mosquito bites and the frequency of these practices; the beliefs about the effectiveness of the specific behaviors to prevent tick and mosquito bites; the sources of information about Lyme disease and arboviral encephalitis; the other prevention practices used by respondents to prevent tick and mosquito bites (open-ended responses); the knowledge of whether the repellent used contained the chemical DEET; the beliefs about the likelihood of oneself or one's children getting sick from using insect repellent; the preference for using a recommended method to remove an embedded tick (tweezers) or a folk-method (hot match head); and the perceived likelihood for purchasing a vaccine against Lyme disease. Further, several sociodemographic variables were also identified that might influence the adoption of precautions to prevent tick and mosquito bites, including newspaper readership and frequency, sources of news information, cat and dog ownership, international travel, education level, age, Hispanic origin, employment status, race, marital status, household size, residence type, urbanicity of residence, length of residence occupancy, health insurance status of respondent and respondent's household, household income, number of telephone numbers in the residence, and gender.

The second objective of this study was to obtain a data set that would be representative of and generalizable to the U.S. adult population. As detailed in Chapter 3: Methods and Materials, this objective was achieved under contract with the Survey

Research Center, University of Maryland, College Park, through funding provided by the National Science Foundation and the Centers for Disease Control and Prevention (CDC).

A third objective of this study was to detail the frequency and distribution of knowledge levels, attitudes, and practices regarding ticks and Lyme disease, and mosquitoes and arboviral encephalitis, as well as to describe those factors that could be predictive of behaviors to prevent tick and mosquito bites. This was accomplished through the use of univariate and multivariate statistical analyses as described in Chapter 3.

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Appendix A: Questionnaire

This is the Survey Research Center at the University of Maryland. We are doing a study for the Centers for Disease Control. The study is about people's health, and the things people do that affect their health.

For this study, I need to speak with the adult in your household, who is 18 or older and will have the **next** birthday. Who would that be?

IF INFORMANT DOES NOT KNOW ALL THE BIRTHDAYS ASK:

Of the ones you do know who will have the **NEXT** birthday?

I need to speak with that person please.

This is the Survey Research Center at the University of Maryland. We are doing a study for the Centers for Disease Control. The study is about people's health, and the things people do that affect their health.

Q1 The first questions refer to last summer. Thinking back to all the places you were during the summer, were there mosquitos anywhere?

- <1> YES
- <2> NO
- <9> REFUSED

a. *If Q1 does not equal <1> go to Q5.*

Q1a Was this in [fill with name of state] or elsewhere?

- <1> ONLY [fill with name of state]
- <2> ONLY ELSEWHERE
- <3> BOTH
- <8> DON'T REMEMBER
- <9> REFUSED

b. *If Q1a does not equal <2> go to Q2.*

Q1b Where was that?

PLEASE RECORD NO MORE THAN 3 MENTIONS

Q2 How concerned were you about being bitten by mosquitos last summer
-- very concerned, somewhat concerned, not too concerned, or not at all
concerned?

- <1> VERY CONCERNED
- <2> SOMEWHAT CONCERNED
- <3> NOT TOO CONCERNED
- <4> NOT AT ALL CONCERNED
- <8> DO NOT KNOW
- <9> REFUSED

Q3 Did you do anything last summer to avoid mosquitos or prevent being bitten by
them?

- <1> YES
- <2> NO
- <8> DO NOT KNOW/DON'T REMEMBER
- <9> REFUSED

c. *If Q3 does not equal <1> go to Q5.*

Q3aa Did you use insect repellent?

- <1> YES
- <2> NO
- <9> REFUSED

d. *If Q3aa does not equal <1> go to Q3bb.*

Q3ab Did you use insect repellent on your skin?

- <1> YES
- <2> NO
- <9> REFUSED

e. *If Q3ab does not equal <1> go to Q3ad.*

Q3ac Did you do that often, sometimes or only occasionally?

- <1> OFTEN
- <2> SOMETIMES
- <3> OCCASIONALLY
- <8> DO NOT KNOW
- <9> REFUSED

Q3ad Did you use insect repellent on your clothes?

- <1> YES
- <2> NO
- <9> REFUSED

f. *If Q3ad does not equal <1> go to Q3bb.*

Q3ae Did you do that often, sometimes or only occasionally?

- <1> OFTEN
- <2> SOMETIMES
- <3> OCCASIONALLY
- <8> DO NOT KNOW
- <9> REFUSED

Q3bb Did you stay indoors in the late afternoon or early evening to avoid mosquitos?

- <1> YES
- <2> NO
- <9> REFUSED

g. *If Q3bb does not equal <1> go to Q3ca.*

Q3bc Did you do that often, sometimes or only occasionally?

- <1> OFTEN
- <2> SOMETIMES
- <3> OCCASIONALLY
- <8> DO NOT KNOW
- <9> REFUSED

Q3ca Did you wear long sleeves **and** pants to avoid mosquitos?

- <1> YES
- <2> NO
- <9> REFUSED

h. *If Q3ca does not equal <1> skip Q3cb.*

Q3cb Did you do that often, sometimes or only occasionally?

- <1> OFTEN
- <2> SOMETIMES
- <3> OCCASIONALLY
- <8> DO NOT KNOW
- <9> REFUSED

i. *If Q3aa, Q3ab, Q3ad, Q3bb or Q3ca equal <1> go to Q4a.*

Q4A What did you do last summer to avoid mosquitos or prevent being bitten by them?

- <1> SPECIFY
- <9> REFUSED

j. *Go to Q5.*

Q4a Did you do anything else last summer to avoid mosquitos or prevent being bitten by them?

- <1> YES - SPECIFY
- <2> NO
- <9> REFUSED

k. *Q4a is coded in the same location as Q4A.*

Q5 The next questions are about how effective some things might be if you were in areas where there were mosquitos.

l. *If Q3ab and Q3ad equal <1> go to Q5A.*

Q5a If you were to use insect repellent on your skin and clothes, how

effective do you think that would be in reducing your chances of mosquito bites -- very effective, somewhat effective, not too effective, or not at all effective?

- <1> VERY EFFECTIVE
- <2> SOMEWHAT EFFECTIVE
- <3> NOT TOO EFFECTIVE
- <4> NOT AT ALL EFFECTIVE
- <8> DO NOT KNOW
- <9> REFUSED

m. ***Skip Q5A.***

Q5A When you use insect repellent on your skin and clothes, how effective do you think that is in reducing your chances of mosquito bites -- very effective, somewhat effective, not too effective, or not at all effective?

- <1> VERY EFFECTIVE
- <2> SOMEWHAT EFFECTIVE
- <3> NOT TOO EFFECTIVE
- <4> NOT AT ALL EFFECTIVE
- <8> DO NOT KNOW
- <9> REFUSED

n. ***Q5A is coded in the same location as Q5a.***

o. ***If Q3bb equal <1> go to Q5B.***

Q5b If you were to stay indoors in the late afternoon or early evening, and go outdoors only at other times, how effective do you think that would be in reducing your chances of mosquito bites -- very effective, somewhat effective, not too effective, or not at all effective?

- <1> VERY EFFECTIVE
- <2> SOMEWHAT EFFECTIVE
- <3> NOT TOO EFFECTIVE
- <4> NOT AT ALL EFFECTIVE
- <8> DO NOT KNOW
- <9> REFUSED

a. ***Skip Q5B.***

Q5B When you stay indoors in the late afternoon or early evening and go

outdoors only at other times, how effective do you think that is in reducing your chances of mosquito bites -- very effective, somewhat effective, not too effective, or not at all effective?

- <1> VERY EFFECTIVE
- <2> SOMEWHAT EFFECTIVE
- <3> NOT TOO EFFECTIVE
- <4> NOT AT ALL EFFECTIVE
- <8> DO NOT KNOW
- <9> REFUSED

b. *Q5B is coded in the same location as Q5b.*

c. *If Q3ca equal <1> go to Q5C.*

Q5c If you were to wear long sleeves and pants, how effective do you think that would be in reducing your chances of mosquito bites -- very effective, somewhat effective, not too effective, or not at all effective?

- <1> VERY EFFECTIVE
- <2> SOMEWHAT EFFECTIVE
- <3> NOT TOO EFFECTIVE
- <4> NOT AT ALL EFFECTIVE
- <8> DO NOT KNOW
- <9> REFUSED

d. *Skip Q5C.*

Q5C When you wear long sleeves and pants, how effective do you think that is in reducing your chances of mosquito bites -- very effective, somewhat effective, not too effective, or not at all effective?

- <1> VERY EFFECTIVE
- <2> SOMEWHAT EFFECTIVE
- <3> NOT TOO EFFECTIVE
- <4> NOT AT ALL EFFECTIVE
- <8> DO NOT KNOW
- <9> REFUSED

e. *Q5C is equivalent to Q5c.*

Q6 How likely is it that using insect repellent on your skin or clothes could

make you sick -- very likely, somewhat likely, not too likely, or not at all likely?

- <1> VERY LIKELY
- <2> SOMEWHAT LIKELY
- <3> NOT TOO LIKELY
- <4> NOT AT ALL LIKELY
- <8> DO NOT KNOW
- <9> REFUSED

Q7 How many children 12 or younger do you have?

- <0> NONE
- <1>
- <2-6>
- <7> 7 OR MORE
- <8> DO NOT KNOW
- <9> REFUSED

- f. *If Q7 equal <1> continue to Q8.*
- g. *If Q7 equal <0> ,<8> or <9> skip Q8 and q8.*
- h. *Other wise, go to q8.*

Q8 How likely is it that using insect repellent on your child's skin or clothes could make the child sick -- very likely, somewhat likely, not too likely, or not at all likely?

- <1> VERY LIKELY
- <2> SOMEWHAT LIKELY
- <3> NOT TOO LIKELY
- <4> NOT AT ALL LIKELY
- <8> DO NOT KNOW
- <9> REFUSED

- i. *Skip q8.*

q8 How likely is it that using insect repellent on your children's skin or clothes could make them sick -- very likely, somewhat likely, not too likely, or not at all likely?

- <1> VERY LIKELY
- <2> SOMEWHAT LIKELY
- <3> NOT TOO LIKELY

- <4> NOT AT ALL LIKELY
- <8> DO NOT KNOW
- <9> REFUSED

- j. *q8 is equivalent to Q8.*
- k. *If Q3aa equal <1> answer Q9, otherwise go to Q10.*

Q9 Did the insect repellent you used last summer contain the chemical DEET, or are you not sure?

- <1> YES, CONTAINED DEET
- <2> NO, DID NOT CONTAIN DEET
- <8> DO NOT KNOW/NOT SURE
- <9> REFUSED

Q10 Now I'd like to ask you about another kind of insect called a tick.

Do you know what ticks are?

- <1> YES
- <2> NO
- <9> REFUSED

- l. *If Q10 does not equal <1> go to Q17.*

Q10a Thinking back to the summer, were there ticks any places you were or are you not sure?

- <1> YES
- <2> NO
- <8> NOT SURE
- <9> REFUSED

- m. *If Q10a equal <1> continue to Q10b.*
- n. *If Q10a equal <8> go to Q11.*
- o. *Otherwise, go to Q15.*

Q10b Was this in [fill with name of state] or elsewhere?

- <1> ONLY [fill with name of state]
- <2> ONLY ELSEWHERE

- <3> BOTH
- <8> DON'T REMEMBER
- <9> REFUSED

p. *If Q10b does not equal <2> go to Q11.*

Q10c Where was that?

PLEASE RECORD NO MORE THAN 3 MENTIONS

Q11 How concerned were you about being bitten by ticks last summer-very concerned, somewhat concerned, not too concerned or not at all concerned?

- <1> VERY CONCERNED
- <2> SOMEWHAT CONCERNED
- <3> NOT TOO CONCERNED
- <4> NOT AT ALL CONCERNED
- <8> DO NOT KNOW
- <9> REFUSED

Q12 Did you do anything last summer to avoid ticks or prevent being bitten by them?

- <1> YES
- <2> NO
- <8> DO NOT KNOW/DON'T REMEMBER
- <9> REFUSED

q. *If Q12 does not equal <1> go to q14.*

Q12a Did you use insect repellent to prevent tick bites?

- <1> YES
- <2> NO
- <9> REFUSED

r. *If Q12a does not equal <1> go to Q12f.*

Q12b Did you use insect repellent on your skin?

- <1> YES

- <2> NO
- <9> REFUSED

s. ***If Q12b does not equal <1> go to Q12d.***

Q12c Did you do that often, sometimes or only occasionally?

- <1> OFTEN
- <2> SOMETIMES
- <3> OCCASIONALLY
- <8> DO NOT KNOW
- <9> REFUSED

Q12d Did you use insect repellent on your clothes?

- <1> YES
- <2> NO
- <9> REFUSED

t. ***If Q12d does not equal <1> go to Q12f.***

Q12e Did you do that often, sometimes or only occasionally?

- <1> OFTEN
- <2> SOMETIMES
- <3> OCCASIONALLY
- <8> DO NOT KNOW
- <9> REFUSED

Q12f Did you wear long sleeves **and** pants to prevent tick bites?

- <1> YES
- <2> NO
- <9> REFUSED

u. ***If Q12f does not equal <1> go to Q12h.***

Q12g Did you do that often, sometimes or only occasionally?

- <1> OFTEN
- <2> SOMETIMES
- <3> OCCASIONALLY
- <8> DO NOT KNOW
- <9> REFUSED

Q12h Did you tuck your pants into socks or boots to prevent tick bites?

- <1> YES
- <2> NO
- <9> REFUSED

v. *If Q12h does not equal <1> go to Q12j.*

Q12i Did you do that often, sometimes or only occasionally?

- <1> OFTEN
- <2> SOMETIMES
- <3> OCCASIONALLY
- <8> DO NOT KNOW
- <9> REFUSED

Q12j Did you stay away from woods or grassy areas to prevent tick bites?

- <1> YES
- <2> NO
- <9> REFUSED

w. *If Q12j does not equal <1> skip Q12k.*

Q12k Did you do that often, sometimes or only occasionally?

- <1> OFTEN
- <2> SOMETIMES
- <3> OCCASIONALLY
- <8> DO NOT KNOW
- <9> REFUSED

x. *If Q12a, Q12b, Q12d, Q12f, Q12h, or Q12j equal <1> go to Q13a*

Q13A What did you do last summer to avoid ticks or prevent being bitten by them?

<1> SPECIFY
<9> REFUSED

y. **Go to q14.**

Q13a Did you do anything else last summer to avoid ticks or prevent being bitten by them?

<1> YES - SPECIFY
<2> NO
<9> REFUSED

z. **Q13a is equivalent to Q13A.**

q14 If random number 3 is less or equal to <4> go to Q14b.

Q14a If you found a tick attached to yourself, would you use tweezers to remove it, or use a hot match, or would you do something else?

<1> USE TWEEZERS
<2> USE HOT MATCH
<3> BOTH
<4> SOMETHING ELSE: SPECIFY
<8> DO NOT KNOW
<9> REFUSED

aa. **Go to Q15.**

Q14b If you found a tick attached to yourself, would you use a hot match to remove it, or use tweezers, or would you do something else?

<1> USE HOT MATCH
<2> USE TWEEZERS
<3> BOTH
<4> SOMETHING ELSE: SPECIFY
<8> DO NOT KNOW
<9> REFUSED

Q15 The next questions are about how effective some things might be if you were in areas where there were ticks.

bb. *If Q12j equal <1> go to Q15A*

Q15a If you stayed away from woods or grassy areas, how effective do you think that would be in reducing your chances of tick bites -- very effective, somewhat effective, not too effective, or not at all effective?

- <1> VERY EFFECTIVE
- <2> SOMEWHAT EFFECTIVE
- <3> NOT TOO EFFECTIVE
- <4> NOT AT ALL EFFECTIVE
- <8> DO NOT KNOW
- <9> REFUSED

cc. *Skip Q15A.*

Q15A When you stay away from woods or grassy areas, how effective do you think that is in reducing your chances of tick bites -- very effective, somewhat effective, not too effective, or not at all effective?

- <1> VERY EFFECTIVE
- <2> SOMEWHAT EFFECTIVE
- <3> NOT TOO EFFECTIVE
- <4> NOT AT ALL EFFECTIVE
- <8> DO NOT KNOW
- <9> REFUSED

dd. *Q15A is equivalent to Q15a.*

ee. *If Q12b and Q12d equal <1> go to Q15B.*

Q15b If you were to use insect repellent on your skin and clothes, how effective do you think that would be in reducing your chances of tick bites -- very effective, somewhat effective, not too effective, or not at all effective?

- <1> VERY EFFECTIVE
- <2> SOMEWHAT EFFECTIVE
- <3> NOT TOO EFFECTIVE
- <4> NOT AT ALL EFFECTIVE
- <8> DO NOT KNOW
- <9> REFUSED

ff. *Skip Q15B.*

Q15B When you use insect repellent on your skin and clothes, how effective do you think that is in reducing your chances of tick bites -- very effective, somewhat effective, not too effective, or not at all effective?

- <1> VERY EFFECTIVE
- <2> SOMEWHAT EFFECTIVE
- <3> NOT TOO EFFECTIVE
- <4> NOT AT ALL EFFECTIVE
- <8> DO NOT KNOW
- <9> REFUSED

gg. *Q15B is equivalent to Q15b.*

hh. *If Q12f equal <1> go to Q15C.*

Q15c If you were to wear long sleeves and pants, how effective do you think that would be in reducing your chances of tick bites -- very effective, somewhat effective, not too effective, or not at all effective?

- <1> VERY EFFECTIVE
- <2> SOMEWHAT EFFECTIVE
- <3> NOT TOO EFFECTIVE
- <4> NOT AT ALL EFFECTIVE
- <8> DO NOT KNOW
- <9> REFUSED

ii. *Skip Q15C.*

Q15C When you wear long sleeves and pants, how effective do you think that is in reducing your chances of tick bites -- very effective, somewhat effective, not too effective, or not at all effective?

- <1> VERY EFFECTIVE
- <2> SOMEWHAT EFFECTIVE
- <3> NOT TOO EFFECTIVE
- <4> NOT AT ALL EFFECTIVE
- <8> DO NOT KNOW
- <9> REFUSED

jj. *Q15C is equivalent to Q15c.*

kk. *If Q12h equal <1> go to Q15D*

Q15d If you were to tuck your pants into boots or socks, how effective do you think that would be in reducing your chances of tick bites -- very effective, somewhat effective, not too effective, or not at all effective?

- <1> VERY EFFECTIVE
- <2> SOMEWHAT EFFECTIVE
- <3> NOT TOO EFFECTIVE
- <4> NOT AT ALL EFFECTIVE
- <8> DO NOT KNOW
- <9> REFUSED

ii. *Skip Q15D.*

Q15D When you tuck your pants into boots or socks, how effective do you think that is in reducing your chances of tick bites -- very effective, somewhat effective, not too effective, or not at all effective?

- <1> VERY EFFECTIVE
- <2> SOMEWHAT EFFECTIVE
- <3> NOT TOO EFFECTIVE
- <4> NOT AT ALL EFFECTIVE
- <8> DO NOT KNOW
- <9> REFUSED

mm. *Q15D is equivalent to Q15d.*

nn. *If the respondent did not answer Q9 and Q12a equal <1> go to Q16.*

Other wise, go to Q17.

Q16 Did the insect repellent you used last summer contain the chemical DEET, or are you not sure?

- <1> YES, CONTAINED DEET
- <2> NO, DID NOT CONTAIN DEET
- <8> DO NOT KNOW/NOT SURE
- <9> REFUSED

oo. *Q16 is equivalent to Q9.*

Q17 Have you read or heard about Lyme Disease?

- <1> YES
- <2> NO

<8> DO NOT KNOW

<9> REFUSED

pp. *If Q17 does not equal <1> go to Q18.*

Q17a Where have you heard the most about Lyme Disease: TV, radio, newspapers, magazines, a doctor, or somewhere else?

<1> TV

<2> RADIO

<3> NEWSPAPERS

<4> MAGAZINES

<5> DOCTORS

<6> SOMEWHERE ELSE, SPECIFY:

<8> DO NOT KNOW/DON'T REMEMBER

<9> REFUSED

Q17b Have you personally known someone who had Lyme Disease?

USE CATEGORIES 3 AND 4 IF RESPONDENT VOLUNTEERS THIS INFORMATION

<1> YES

<3> YES RESPONDENT HAD IT

<2> NO

<4> YES RESPONDENT'S CHILD HAD IT

<9> REFUSED

Q17c Do you know how someone gets Lyme Disease?

<1> YES - How does someone get it?

<2> NO

<9> REFUSED

Q17d Would you say Lyme Disease is an extremely serious illness, a very serious illness, somewhat serious, or not too serious?

<1> EXTREMELY SERIOUS

<2> VERY SERIOUS

<3> SOMEWHAT SERIOUS

<4> NOT TOO SERIOUS

<8> DO NOT KNOW

<9> REFUSED

qq. *If Q7 equal <0> or is greater or equal to <8> skip Q17e.*

Q17e How about for children? Would you say Lyme Disease is an extremely serious illness for children, a very serious illness for children, somewhat serious, or not too serious?

- <1> EXTREMELY SERIOUS
- <2> VERY SERIOUS
- <3> SOMEWHAT SERIOUS
- <4> NOT TOO SERIOUS
- <8> DO NOT KNOW
- <9> REFUSED

rr. *If Q17b equal <3> go to Q17F.*

Q17f On a scale of 0 to 100 where 0 means you will never get Lyme Disease. and 100 means you will definitely get it, how likely do you think it is that you will ever get Lyme Disease?

- <0>
- <1-100>
- <888> DO NOT KNOW
- <999> REFUSED

ss. *Skip Q17F.*

Q17F On a scale of 0 to 100 where 0 means you will never again get Lyme Disease, and 100 means you will definitely get it, how likely do you think it is that you will ever again get Lyme Disease?

- <0>
- <1-100>
- <888> DO NOT KNOW
- <999> REFUSED

tt. *Q17F is equivalent to Q17f.*

uu. *If Q7 equal <0> or is greater or equal to <8> skip Q17g, Q17h and Q17i.*

vv. *If Q17b equal <4> and Q7 equal <1>, go to Q17i.*

ww. *If Q7 is greater than <1> and Q17b does not equal <4>, go to Q17h.*

xx. *If Q7 is greater than <1> and Q17b equal <4>, go to 17i.*

Q17g On a scale of 0 to 100 where 0 means your child will never get Lyme Disease, and 100 means he or she will definitely get it, how likely do you think it is that your child will ever get Lyme Disease?

<0>
<1-100>
<888> DO NOT KNOW
<999> REFUSED

yy. ***Skip Q17h and Q17i.***

Q17h On a scale of 0 to 100 where 0 means your children will never get Lyme Disease, and 100 means one of them will definitely get it, how likely do you think it is that any of your children will ever get Lyme Disease?

<0>
<1-100>
<888> DO NOT KNOW
<999> REFUSED

zz. ***Q17h is equivalent to Q17g. Skip Q17i.***

Q17i On a scale of 0 to 100 where 0 means your child will never again get Lyme Disease, and 100 means he or she will definitely get it, how likely do you think it is that your child will ever again get Lyme Disease?

<0>
<1-100>
<888> DO NOT KNOW
<999> REFUSED

aaa. ***Q17i is equivalent to Q17g.***

Q17i On a scale of 0 to 100 where 0 means any of your children will never again get Lyme Disease, and 100 means one of them will definitely get it, how likely do you think it is that any of your children will ever again get Lyme Disease?

<0>
<1-100>
<888> DO NOT KNOW
<999> REFUSED

bbb. *17i is equivalent to Q17g.*

ccc. *If Q17f or Q17g equal <0> go to Q18.*

ddd. *If random number 4 is less or equal to <4>, store <50> as dollar amount. Otherwise, store <100> as dollar amount.*

Q17j Suppose there were a safe and effective vaccine, which -- if taken every year -- would protect against Lyme Disease. If the vaccine to prevent Lyme Disease cost you \$[fill with dollar amount], which was not covered by a health plan, would you get it?

- <1> YES
- <2> NO
- <8> DO NOT KNOW
- <9> REFUSED

eee. *If Q17j does not equal <1> go to Q18.*

fff. *If random number 5 is less or equal to <4>, store <50> as percentage. Otherwise, store <75> as percentage.*

Q17k Would you pay for it if it were only [fill with percentage]% effective?

- <1> YES
- <2> NO
- <8> DO NOT KNOW
- <9> REFUSED

Q18 Have you read or heard about Encephalitis?

- <1> YES
- <2> NO
- <8> DO NOT KNOW
- <9> REFUSED

ggg. *If Q18 does not equal <1> go to Q19.*

Q18a Where have you heard the most about Encephalitis: from TV, radio, newspapers, magazines, a doctor, or somewhere else?

- <1> TV
- <2> RADIO
- <3> NEWSPAPERS

- <4> MAGAZINES
- <5> DOCTORS
- <6> SOMEWHERE ELSE, SPECIFY:
- <8> DO NOT KNOW/DON'T REMEMBER
- <9> REFUSED

Q18b Have you personally known someone who had Encephalitis?

USE CATEGORIES 3 AND 4 IF RESPONDENT VOLUNTEERS THIS INFORMATION

- <1> YES
- <2> NO
- <3> YES RESPONDENT HAD IT
- <4> YES RESPONDENT'S CHILD HAD IT
- <9> REFUSED

Q18c Do you know how someone gets Encephalitis?

- <1> YES - How does someone get it?
- <2> NO
- <9> REFUSED

Q18d Would you say Encephalitis is an extremely serious illness, a very serious illness, somewhat serious, or not too serious?

- <1> EXTREMELY SERIOUS
- <2> VERY SERIOUS
- <3> SOMEWHAT SERIOUS
- <4> NOT TOO SERIOUS
- <8> DO NOT KNOW
- <9> REFUSED

hhh. *If Q7 equal <0> or, is greater or equal to <8>, skip Q18e.*

Q18e How about for children? Would you say Encephalitis is an extremely serious illness for children, a very serious illness for children, somewhat serious, or not too serious?

- <1> EXTREMELY SERIOUS
- <2> VERY SERIOUS
- <3> SOMEWHAT SERIOUS
- <4> NOT TOO SERIOUS
- <8> DO NOT KNOW

<9> REFUSED

iii. *If Q18b equal <3> go to Q18F.*

Q18f On a scale of 0 to 100 where 0 means you will never get Encephalitis and 100 means you will definitely get it, how likely do you think it is that you will ever get Encephalitis?

<0>

<1-100>

<888> DO NOT KNOW

<999> REFUSED

jjj. *Skip Q18F.*

Q18F On a scale of 0 to 100 where 0 means you will never again get Encephalitis and 100 means you will definitely get it, how likely do you think it is that you will ever again get Encephalitis?

<0>

<1-100>

<888> DO NOT KNOW

<999> REFUSED

kkk. *Q18F is equivalent to Q18f.*

lll. *If Q7 equal <0> or, is greater or equal to <8>, go to Q19.*

mmm. *If Q7 equal <1> and Q18b equal <4>, go to Q18i.*

nnn. *If Q7 is greater than <1> and Q18b equal <4>, go to 18i.*

ooo. *If Q7 is greater than <1> and Q18b not equal <4>, go to Q18h.*

Q18g On a scale of 0 to 100 where 0 means your child will never get Encephalitis and 100 means he or she will definitely get it, how likely do you think it is that your child will ever get Encephalitis?

<0>

<1-100>

<888> DO NOT KNOW

<999> REFUSED

ppp. *Go to Q19.*

Q18h On a scale of 0 to 100 where 0 means your children will never get Encephalitis and 100 means one of them will definitely get it, how likely do you think it is that any of your children will ever ~~En~~ get Encephalitis?

- <0>
- <1-100>
- <888> DO NOT KNOW
- <999> REFUSED

qqq. *Q18h is equivalent to Q18g.*

rrr. *Go to Q19.*

Q18i On a scale of 0 to 100 where 0 means your child will never again get Encephalitis and 100 means he or she will definitely get it, how likely do you think it is that your child will ever again get Encephalitis?

- <0>
- <1-100>
- <888> DO NOT KNOW
- <999> REFUSED

sss. *Q18i is equivalent to Q18g.*

ttt. *Go to Q19.*

18i On a scale of 0 to 100 where 0 means any of your children will never again get Encephalitis and 100 means one of them will definitely get it, how likely do you think it is that any of your children will ever again get Encephalitis?

- <0>
- <1-100>
- <888> DO NOT KNOW
- <999> REFUSED

uuu. *Q18h is equivalent to Q18g.*

Q19 Have you read or heard anything about Bubonic Plague?

- <1> YES
- <2> NO
- <8> DO NOT KNOW
- <9> REFUSED

vvv. *If Q19 does not equal <1> go to Q20.*

Q19a Do you think anyone in the United States gets Bubonic Plague today?

- <1> YES
- <2> NO
- <8> DO NOT KNOW
- <9> REFUSED

Q20 Now I have some questions on another topic, do you read a newspaper regularly?

- <1> YES
- <2> NO
- <8> DO NOT KNOW
- <9> REFUSED

www. *If Q20 does not equal <1> go to Q21.*

Q20a How many days a week do you read it?

- <1-7>
- <8> DO NOT KNOW
- <9> REFUSED

Q21 Do you get most of your news from newspapers or television?

- <1> MOSTLY NEWSPAPERS
- <2> MOSTLY TELEVISION
- <3> BOTH EQUALLY
- <4> NEITHER
- <8> DO NOT KNOW
- <9> REFUSED

Q22 Do you have any dogs or cats?

- <1> DOGS
- <2> CATS
- <3> BOTH
- <4> NEITHER
- <8> DO NOT KNOW

<9> REFUSED

Q23 Have you ever been to Asia, Africa, or Central or South America?

<1> YES

<2> NO

<8> DO NOT KNOW

<9> REFUSED

P1 Finally, I'd like to ask you some background questions.

What is the last grade or year of school you completed?

<0> NONE

<1-7> SOME ELEMENTARY

<8> ELEMENTARY SCHOOL

<9-11> SOME HIGH SCHOOL

<12> HIGH SCHOOL GRAD

<13-15> SOME COLLEGE

<16> COLLEGE GRAD

<17> SOME GRADUATE SCHOOL

<18> GRADUATE OR PROFESSIONAL DEGREE

<99> REFUSED

P2 In what month and year were you born?

ENTER MONTH

<1> JANUARY

<7> JULY

<2> FEBRUARY

<8> AUGUST

<3> MARCH

<9> SEPTEMBER

<4> APRIL

<10> OCTOBER

<5> MAY

<11> NOVEMBER

<6> JUNE

<12> DECEMBER

<99> REFUSED

P2a ENTER YEAR

<00> BEFORE 1900

<01-80>

<99> REFUSED

P3 Are you of Hispanic origin or descent?

- <1> YES
- <2> NO
- <9> REFUSED

P4 Are you:

- <1> white
- <2> black
- <3> Asian
- <4> or another race? SPECIFY:
- <9> REFUSED

P5 Are you currently:

- <1> employed full-time
- <2> part-time
- <3> or not employed at all?
- <9> REFUSED

xxx. If P5 does not equal <3> go to P6.

P5a Is that mainly because you are:

- <1> retired
- <2> keeping house
- <3> temporarily unemployed
- <4> a student
- <5> or disabled?
- <7> OTHER -- SPECIFY
- <9> REFUSED

P6 Are you currently:

- <1> married
- <2> separated
- <3> divorced
- <4> widowed
- <5> or have you never been married?
- <9> REFUSED

P7 Counting yourself, how many adults age 18 or older live in this household?

- <1-10>
- <11> MORE THAN 10
- <99> REFUSED

P8 Is your home a **detached** single family house, a rowhouse, townhouse or duplex, or is it an apartment or condominium?

- <1> SINGLE HOUSE
- <2> ROWHOUSE/TOWHOUSE/DUPLEX
- <3> APARTMENT/CONDO
- <4> OTHER, SPECIFY:
- <8> DO NOT KNOW
- <9> REFUSED

P9 Do you live in a city, suburb, small town, or rural area?

- <1> CITY
- <2> SUBURB
- <3> SMALL TOWN
- <4> RURAL AREA
- <8> DO NOT KNOW
- <9> REFUSED

P10 How many years have you lived at your present address?

- <0> LESS THEN 1 YEAR
- <1-86>
- <87> 87 OR MORE
- <88> DO NOT KNOW
- <99> REFUSED

P10a In what state did you spend most of last summer?

yyy. If P7 equal <1> and Q7 equal <0>, go to P11a.

P11 Are all the members of your household covered by health insurance?

- <1> YES
- <2> NO
- <8> DO NOT KNOW

<9> REFUSED

zzz. *If P11 equal <1> or <9> go to Q12.*

P11a Are you covered by health insurance?

<1> YES

<2> NO

<9> REFUSED

P12 If you added together all the yearly incomes, before taxes, of all the members of your household for last year, 1997, would the total be more than \$30,000?

<0> NO

<1> YES

<9> DO NOT KNOW/REFUSED

aaaa. *If P12 equal <1> go to P12c.*

bbbb. *If P12 equal <9> go to hinc.*

P12a Was it more than \$20,000?

<0> NO

<1> YES

<9> DO NOT KNOW/REFUSED

cccc. *If P12a equal <1> go to hinc.*

dddd. *If P12a equal <9> go to hinc.*

P12b Was it more than \$12,000?

<0> NO

<1> YES

<9> DO NOT KNOW/REFUSED

eeee. *Go to hinc.*

P12c Was it more than \$50,000?

<0> NO

- <1> YES
- <9> DO NOT KNOW/REFUSED

ffff. *If P12c does not equal <1> go to hinc.*

P12d Was it more than \$75,000?

- <0> NO
- <1> YES
- <9> DO NOT KNOW/REFUSED

gggg.*If P12d does not equal <1> go to hinc.*

P12e Was it more than \$100,000?

- <0> NO
- <1> YES
- <9> DO NOT KNOW/REFUSED

hinc Household Income (recoded from the P12 question series)

- <1> \$12,000 or less
- <2> \$20,000 or less
- <3> \$30,000 or less
- <4> \$12,001 - 20,000
- <5> \$20,001 - 30,000
- <6> \$30,001 - 50,000
- <7> \$50,001 - 75,000
- <8> more than \$30,000
- <9> more than \$50,000
- <10> \$75,000 - 100,000
- <11> more than \$75,000
- <12> more than \$100,000
- <99> DO NOT KNOW/REFUSED

zip What is your zipcode?

- <0-99990>
- <99999> DO NOT KNOW/REFUSED

T1 Does this residence have any other telephone numbers in addition to this one?

- <1> YES
- <2> NO
- <9> REFUSED

hhhh. *If T1 does not equal <1> go to f2.*

T2 Altogether, how many different telephone numbers does this residence have?

- <2-20>
- <99> REFUSED

iiii. *If T2 equal <99> go to f2.*

T3 How many are used only for business, computer, FAX, or are for cellular phones?

HAS TO BE SMALLER THAN [fill with answer to T2]

- <0> NONE
- <1-20>
- <99> REFUSED

jjjj. *If T2 equal <99> go to f2.*

kkkk. *If T2 equal T3 go to cht. Otherwise, go to f2.*

cht You said that **all** numbers there are used **only** for business, computer, FAX, or are for cellular phones. Is that correct?

- <1> YES, THIS IS NOT A RESIDENCE, IT IS A BUSINESS
- <2> NO, THIS IS A RESIDENCE

llll. *If cht equal <1> terminate the interview*

Those are all the questions I have. Thank you for your time and help.

Appendix B: Open-ended responses

Did you do anything else last summer to avoid ticks to prevent being bitten by them?

Case Text

00028: Only sprayed the yard

00336: Check body

00411: Stayed away from tick

00566: Dipped dogs and sprayed yard

00672: Sprayed dogs and yard

00711: Sprayed dog

01192: Nothing

01552: Wear a ball cap

01564 : Lived in Alaska last summer, not effective

01667: Checked yourself after

01736: Check for ticks

01967: Checked each other

02041 : Used something around base of house which keeps ticks & other insects out, cat cleaned at vet

02193: Terminator

02288: Did not like the stuff used for mosquitos, skin so soft

02631: Stayed out of long grass

02645: Granule stuff you put out and spray with water hose

03320: Sprayed yard

03321: Checked hair and clothing when coming indoors

03398: Hats, long sleeve shirts, check yourself over as they dig in

03486: Try not to brush the trees

03504: Had pets dipped and house sprayed

03508: Raised guineas

03541: Nothing stay on path

03878: Sprayed the house once a year

03907: Checked myself

04057: Garlic capsules, powdered sulfur

04088: Wore hat and checked for ticks

20094: Inspect self

20197: Wear socks and shoes

20583: Did wear sox when running

20709: Checked whole family over for ticks

20769: Wore shoes instead of barefoot

00007: Stay away from water

00035: Checked children's heads for ticks

00036: Avoided areas where they might be and checked the dog

00039: Campfire

00140: Diazanone granules put out all over the lawn and flower beds & around the house

00160: Wore a hat

00176: Wore a hat

00192: When coming in check clothing and the body

00209: Body searching, scalp

00294: Fumigator

00304: Checking my legs

00309: Nightly search

00492: Did not take the dog to Cape or Martha's Vineyards with them because there were ticks there

00536: Careful

00585: Removed them from dog

00599: Insecticide in and out of the house
00635: Sprayed
00708: Took nutritional supplement that ticks and mosquitos
00721: Wore pants with elastic bottoms
00735: Spray sox with DEET
00745: Checked themselves afterwards
00804: Stayed home
00806: Inspected themselves after spending time in grassy areas - tall grassy meadows or woods (visual inspection of each other when in area populated with ticks
00845: Head checks, monitoring
00861: Treated the yard
00883: Clean the yard with insect repellent
00886: Wore hats
00892: Stayed away from specific areas
00916: Wear hats
01143: Shot grass
01147: Wife check the kids, their skin
01200: Kids aware of them, communication
01227: Staying out of the thick branches & the swamp
01296: Checked person
01336: Sprayed area
01380: Put stiff on yard
01420: Stayed in father's backyard
01444: Took showers
01469: Yard sprayed
01479: Put collars on dogs; had them dipped; sprayed outside around the house every 23 weeks (they live in a field)
01615: Tried other chemicals
01706: Cool you down with wet rags
01746: Wore a hat & checked son & dog & stayed out of the trees s much as possible
01761: Sprayed the animals, trimmed bushes back, and went to hair dresser and discovered tick and then trimmed trees (pack) back
01789: Checked ourselves
01798: When walking through woods was cautious and tried to walk around bushes and trees
01824: Covered the area, stay out the woods until July 4
01839: Checks
01848: Stay away from area
01849: Stayed away from garden-didn't do too much work
01855: Avoided going out in the evening
01889: Tick checks
01901: Medical precautions and body searches for ticks
01943: Stay clear' and tick spray
01970: Wore a hat - is a boy scout leader
02073: Collar on dogs
02079: Be aware of risk
02088: Repellent on dogs
02093: Checked clothing and hair
02245: Checked skin for ticks
02251: Nope
02260: Sprayed & put out cotton ball things with chemicals on them which the rodents take back to their nests & gave dogs medicine so they would not get ticks
02280: Wore a hat
02316: Stayed indoors
02317: They wore hats in woodsy areas
02391: Stay away from high grassy areas, and if I go into the area I would check myself my clothes and body

02453: Sprayed yard for them
02476: Stayed on the trails
02517: Stay away from them
02629: Skin so soft
02666: Stayed indoors
02674: Wore a hat
02687: When asked if he knew about ticks, said no now mentioned earlier that he checks himself
02702: Not walk around barefoot
02769: Check for tick bites
02859: Treated the animal for tick
02893: Stay out the woods at the end summer
03024: Check yourself when you come inside
03081: Avoiding such areas as grassy
03168: Don't go near places where ticks could be
03238: Paid attention
03325: Treated the animal and yard
03480: Buying dog an insect collar
03521: Spray dogs with liquid treatment between shoulder blades
03521: Called top spot
03623: Stayed away from animals in the area
03755: Cutting grass low, and tick granule(rocks)
03898: Sprayed my yard and my dog
03928: Created smoke
04010: Checked self

Did you do anything else last summer to avoid mosquitos or prevent being bitten by them?

Case Text

00035 : Closed doors, fly swatted
00209: Avon product-skin softener
00215: Cream
00242: Stayed inside
00411: Close the door and window
00433: Make sure their was no standing water
00674: Burn candles
00698: They don't bite her so she did not do anything
00897: Skin so soft
00919: Candles, and lemon grass
01375: Protect from grassy areas
01444: Took Vitamins
01676: Nothing, did not worry
01806: Softsence, a product made by Avon, not too sure exactly what it was
02135: Leave the area
02143: Burn candle and use off insect spray
02193: Yard Spray
02363: Nothing
02689: Bug spray
02698: Avon
02746: Burned off candles
03054: Candles
03328 : Nothing
03366: Avon Skin-so-soft
03398: Eat garlic, and it sweats out
03720: Avon skin so soft
03905: Skin so soft by Avon
04026: Light citronella candles
04160: Skin so soft
20065: Slap them
20205 : Spray, candles
20308: Take a supplement
20397: Candles
20710: Did not go near grass
00007: Stay away from sweets

00039: Candles
00061: Don't leave doors open at night
00087: Candle repellent
00126: made sure there wasn't stagnant water
00142: Eliminate their habitat
00147: Dump out standing water
00152: Wore Avon skin so soft
00208: Burned citronella candles
00214: Tried to avoid areas they might be around
00218: Tried to keep water drained
00230: Keep grass cut
00231: Use skin so soft
00277: Burn citronella candles
00304: Citronella Candles
00305: Burn repellent
00329: Did not put on any cologne
00338: Candles
00345: Stayed away from swampy stagnant areas; tried to empty buckets of water
00371: Used skin so soft, used yard guard, used candles
00391: Burn citronella candles
00405: Make sure there is no access for them to get into the house
00415: Citronella Candles
00422: Candles
00467: Stayed away from area
00472: Burned candles
00478: Mosquito netting
00490: Used a type of candle
00501: Torches (citronella)
00503: Citronella candles and torches
00520: Candles
00596: Malaria pills
00599: Citronella Candles
00612: Insect repellent and clothes
00635: Don't leave things around the house with sitting water
00649: Citronella bats
00650: Did not wear things like perfume that would attract mosquitos

00680: Burn candles
 00689: Citronella Candles
 00700: Citronella candles
 00721: Burned smoke producing coils
 00740: Treated yard
 00765: Candles only once
 00780: Stayed away from the creek in my back yard
 00830: Call the city
 00844: Avon skin so soft
 00845: Citron, lemony candles
 00878: Lawn treatment
 00891: Sprayed bushes
 00903: Incense type thing
 00968: Fogger, propane--no standing water
 00970: Keep my doors closed
 00985: Eliminate stagnant water
 01016: Burn candles
 01022: Creams, skin softener
 01027: Sprayed the home and kept doors closed
 01042: Burned candles, bought a yard fogger
 01073: Citronella
 01107: Sprayed the yard
 01143: Went somewhere else ✓
 01147: Avoid the area
 01149: Lamps burnt
 01164: Tried to eat right
 01177: Citronella candles
 01182: Emptied standing water in containers
 01186: Stay away from water and wood at night
 01195: Outdoor sprays, foggers in the yard, depends if mosquito traps are used
 01227: Tried to avoid places where they congregated and they put up Martin bird houses & the Martins helped keep them under control
 01242: Wristband
 01306: Skin so soft repellent
 01420: Made sure objects were away from mosquitos
 01469: Yard sprayed
 01473: Long sleeve
 01490: Garlic
 01523: Specific types of candles
 01525: Citronella candles
 01628: Sprayed lawn
 01669: Bonfires
 01706: Candles - insect repellants
 01707: Come inside
 01727: Spray the yard and avoid their pond
 01761: Left to go to Vermont
 01768: Citronella Candles
 01779: Left location
 01797: Sprayed insecticide inside house
 01824: Using netting or hat
 01839: Candles
 01849: Mosquito eater-scent
 01850: Candles
 01853: Citronella Candles
 01864: When at home went indoors
 01889: Used citronella candles
 01896: Used skin so soft
 01901: Turned off lights at night to prevent mosquitos
 01912: Lotion
 01933: Avon product -skin softener
 01947: Balm campy
 01967: Citronella candles, and plants that repel mosquitos
 01980: Burning citronella candles & make sure no water lying around
 01986: Sprayed
 02016: Get rid of water the house. attract some birds mosquitos
 02073: Spray insecticide in the area, use citronella candles
 02111: Used lotion
 02136: Burned citronella candles
 02157: Spray to keep away
 02165: Burn candles
 02203: Outside under tent
 02231: Candles

02240: Stay away from standing water
 02245: Bought candle
 02251: Avoiding swampy & forested areas
 02260: Had mosquito control commission
 come and spray
 02272: Citronella candle
 02280: Sprayed outside and lit candles
 02282: Stayed away from where they were-
 any water that collected anything that was
 stagnant
 02288: If outside use citronella candles
 02317: Citronella candles, used them outside
 02359: Sprayed herself with cutter and sprayed
 her horse with repellent
 02367: Used special lotion
 02373: Citronella Candles
 02394: Sprayer in house
 02408: Lit citronella candles and off
 02417: Netting when camping; citronella
 candles
 02445: Candles at nighttime
 02457: Left NJ for vacation
 02541: Close the door and window
 02546: Keeping stagnant water out of the yard
 02551: Slap them
 02567: Spread mosquito preventive chemical
 on ground
 02592: Burning citronella candles and mosquito
 candles
 02606: Light candles citronella
 02666: Spray
 02674: Got rid of standing water
 02730: Candles
 02753: Screen in patio
 02757: Citronella candles or tiki torches with
 citronella in them
 02757: Avon skin so soft
 02830: Used insect repellent
 02857: Cleaned up standing water around the
 house
 02859: Empty water insect screen
 02882: Candles
 02905: Empty water bucket
 02927: Burned citronella candles
 02930: Drained water
 02941: Coming in early
 02949: Candles
 03081: Eating garlic
 03111: Vinegar
 03195: Used citronella candles when on the
 porch
 03250: Wore less colognes and stay cool and
 clean
 03274: Took dominion over the mosquitoes
 per Genesis 1:26-27
 03297: Candles
 03304: Skin so soft(AVON)
 03320: Sprayed yard
 03325: Treated the yard
 03338: Citronella Candles
 03345: Used sheets of fabric softener on hair,
 skin, and clothes
 03363: Walk at night
 03383: Lit a citrus bug candle on the porch
 03389: AC in the car
 03416: Burned candles
 03421: Candles
 03490: Candles
 03547: Stay on the porch
 03554: Burn candles
 03556: Raid
 03567: Plants and candles
 03591: Burn citronella candles
 03619: MUSKOIL
 03640: Citronella Candles
 03647: Light citronella candle
 03691: Candles
 03694 Q4a : 1:os:Stayed away from the marsh
 03711: Used insect candles
 03719: Florescent light bulb
 03730: Lit the little insect repellent candles
 03791: Candles
 03793: Screen
 03802: Sprayed with hose

03821: Candles
03878: Burning firecracker punks
03942: Spray the yard
04006: Burned candles
04055: Burn fire
04087: Citronella Candles
04095: Citronella candles on porch
04114: Burning candles
04119: Spray the shrubbery outside
04144: Bug lights
04154: Citronella Candles
04170: Used powder
04186: Cut the grass low and keep it that way
20012: Candles
20056: Burn candles
20117: Lotion
20138: Sprayed in house
20155: Burned candles and used lotion
20159: Bath oil
20173: Citronella
20253: Candles in the yard
20263: Skin so soft
20279: She shooed them away
20280: Candles
20351: Candles
20391: Sprayed the yard with chemicals
20398: I used "skin so soft"--a bath oil from
Avon, many people use it as
20398: Insect repellent
20417: Bug-lite-zappers
20457: Swat them
20460: Citronella
20567: Had the patio screened in
20571: Stayed away from wooded areas
20583: Citronella Candles
20677: Citronella
20700: Citronella candles, stayed in screened
rooms
20717: Citronella candles, mosquito netting
20725: Don't use perfumes or hair sprays
20772: Insect candles
20785: Citronella candles

Appendix C: Tables

Table 1. Number of reported cases and rates of Lyme disease, 10 states, 1998(Centers for Disease Control and Prevention 2000c)		
State	Number of Cases (% of total)	Cases per 100,000 persons
New York	29,172 (32.8)	23.3
Connecticut	15,523 (17.8)	67.9
Pennsylvania	13,020 (14.6)	15.4
New Jersey	10,852 (12.2)	19.9
Wisconsin	3,237 (3.6)	9.5
Rhode Island	3,128 (3.5)	44.8
Maryland	2,758 (3.1)	8.3
Massachusetts	2,118 (2.4)	2.1
Minnesota	1,522 (1.7)	5.0
Delaware	883 (1.0)	18.5

Table 2. Study variables included in questionnaire.

Variable Category	Variables related to the vector and disease			
	Mosquitoes	Encephalitis	Ticks	Lyme disease (LD)
Basic knowledge	<ul style="list-style-type: none"> - Saw mosquitos anywhere - Insect repellent contains chemical DEET 	<ul style="list-style-type: none"> - Read or heard about encephalitis - Sources of information about encephalitis 	<ul style="list-style-type: none"> - Knows what are ticks - Saw ticks anywhere 	<ul style="list-style-type: none"> - Read or heard about LD - Sources of information about LD
Severity of hazard for others		<ul style="list-style-type: none"> - Personally known someone who had encephalitis - Knows how someone gets encephalitis - Perceived seriousness of encephalitis for adults - Perceived seriousness of encephalitis for children 		<ul style="list-style-type: none"> - Personally known someone who had LD - Knows how someone gets LD - Perceived seriousness of LD for adults - Perceived seriousness of LD for children

Table 2. (continued...)

<p>Susceptibility of hazard for self and children</p>	<ul style="list-style-type: none"> - Concerned about being bitten - Likely that insect repellent on skin or clothes could make self sick - Likely that insect repellent on skin or clothes could make children sick 	<ul style="list-style-type: none"> - Likelihood of getting encephalitis - Likelihood of children getting encephalitis 	<ul style="list-style-type: none"> - Concerned about being bitten 	<ul style="list-style-type: none"> - Likelihood of getting LD - Likelihood of children getting L
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Table 2. (continued...)

<p>Specific precautions and frequency</p>	<ul style="list-style-type: none"> - Did anything avoid mosquitos or prevent being bitten - Use insect repellent - Use insect repellent on skin and - Frequency on skin - Use insect repellent on clothes - Frequency on clothes - Stay indoors in the late afternoon or early evening - Frequency staying indoors - Wear long sleeves and pants - Frequency wearing long sleeves and pants - Do anything else yo avoid or prevent bites 		<ul style="list-style-type: none"> - Did anything do avoid ticks or prevent being bitten - Use insect repellent - Use insect repellent on skin and - Frequency on skin - Use insect repellent on clothes - Frequency on clothes - Wear long sleeves and pants - Frequency wearing long sleeves and pants - Tuck your pants into socks or boots - Frequency tucking your pants into socks or boots - Stay away from woods or grassy areas - Frequency 	<p>- Likelihood of getting a vaccine against LD</p>
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Table 2. (continued...)

<p>Effectiveness of precautions</p>	<ul style="list-style-type: none"> - Using Insect repellent on skin and clothes - Staying indoors - Wearing long sleeves and pants 		<ul style="list-style-type: none"> - Staying away from woods or grassy areas - Using insect repellent on skin and clothes - Wearing long sleeves and pants - Tucking pants into boots and socks 	
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Table 2. (continued...)

<p>Socio- demo- graphics</p>	<ul style="list-style-type: none"> - Newspaper readership - Frequency of newspaper reading - Newspapers and/or television as source of news - Dogs and/or cat ownership - Travel to Asia, Africa, or Central or South America - Education level - Age - Hispanic origin or descent - Race - Employment status - Reason unemployed - Marital status - Number of adults in household size - Number of children 12 or younger in household - Residence type - Residence location - Years living at residence - Household health insurance coverage - Personal health insurance coverage - Number of telephone numbers at residence - Number of lines used only for business, computer, FAX, or cellular phones - State where previous summer spent - Household income
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Table 3. Standard Errors in Percentage Points of Estimated Percentages at the 95% confidence level. (Survey Research Center 1998)

Sample size (n)	Percentage				
	50.0	60 or 40	70 or 30	80 or 20	90 or 10
25	24.4%	23.9%	22.4%	19.6%	14.7%
50	17.3%	17.0%	15.8%	13.8%	10.4%
100	12.2%	12.0%	11.2%	9.7%	7.4%
200	8.6%	8.5%	8.0%	6.9%	5.2%
300	7.1%	6.9%	6.5%	5.6%	4.2%
400	6.1%	6.0%	5.6%	4.9%	3.6%
500	5.5%	5.4%	5.0%	4.4%	3.2%
600	5.0%	4.9%	4.6%	4.0%	3.0%
700	4.6%	4.5%	4.2%	3.7%	2.7%
800	4.4%	4.2%	4.0%	3.5%	2.6%
900	4.1%	4.0%	3.7%	3.2%	2.5%
1000	3.9%	3.7%	3.5%	3.1%	2.4%
1250	3.5%	3.4%	3.1%	2.7%	2.1%
1500	3.1%	3.1%	2.9%	2.5%	1.9%
1750	2.9%	2.9%	2.7%	2.4%	1.8%

Table 4a. Disposition of the 4,200 telephone numbers in the cross-sectional sample(Survey Research Center 1998)

Phone Numbers	Number	Eligible Households	Number	Percent
Non-household	1,437	Interviews	1,489	60.4%
Never answered	297	Refusals	504	20.4%
Eligible household	2,466	Not-at-homes	332	13.5%
Total	4,200	Misc. problems	141	5.7%
		Total	2,466	100.0%

Table 4b. Disposition of the 800 telephone numbers in the over-sample (Survey Research Center 1998)

Phone Numbers	Number	Eligible Households	Number	Percent
Non-household	246	Interviews	261	52.3%
Never answered	55	Refusals	107	21.4%
Eligible household	499	Not-at-homes	102	20.4%
Total	800	Misc. problems	29	5.8%
		Total	499	100.0%

Table 5. Comparison of selected sociodemographic variables between U.S. sample and six states Northeastern U.S., 1998.

Variable	Number (%) ^a		X ² value ^b	df
	National	Six states in Northeastern U.S. ^c		
Reads newspaper regularly	841 (67.5)	360 (71.4)	2.398*	1
Reads newspaper more than 4 days/wk	609 (72.8)	274 (76.8)	1.785*	1
Gets news mostly from:			1.574	3
newspapers	273 (21.9)	120 (24.0)		
TV	606 (48.6)	229 (45.7)		
both equally	305 (24.5)	124 (24.8)		
neither	62 (5.0)	28 (5.6)		
Has dogs or cats:			31.072****	4
dogs	336 (26.9)	115 (23.0)		
cats	146 (11.7)	78 (15.6)		
both	217 (17.4)	44 (8.8)		
neither	546 (43.8)	264 (52.7)		
Has been to Asia/Africa/South America	216 (17.3)	88 (17.6)	0.001	1
Employment status			9.650***	2
Full time	684 (56.0)	243 (49.3)		
Part time	162 (13.3)	60 (12.2)		
Not employed	376 (30.8)	190 (38.5)		

Table 5. (continued...)

Reason for unemployment:			13.231**	5
Retired	195 (52.0)	96 (50.5)		
Keeping house	85 (22.7)	41 (21.6)		
Temp. unemployed	19 (5.1)	19 (10.0)		
Student	18 (4.8)	16 (8.4)		
Disabled	36 (9.6)	7 (3.7)		
Other	22 (5.9)	11 (5.8)		
Marital status			4.040	4
Married	744 (61.2)	284 (58.2)		
Separated	23 (1.9)	8 (1.6)		
Divorced	113 (9.3)	38 (7.8)		
Widowed	77 (6.3)	38 (7.8)		
Never Married	258 (21.2)	120 (24.6)		
Family covered by health insurance	939 (86.5)	361 (83.6)	6.518**	2
Respondent is covered by health insurance (if family is not)	162 (56.6)	74 (58.3)	1.380	2
Has additional phone number in household	108 (8.9)	47 (9.7)	0.225	1
Respondent's age:			0.942	6
18 to 24	152 (12.7)	55 (11.6)		
25 to 34	251 (20.9)	95 (20.0)		
35 to 44	265 (22.1)	104 (21.9)		
45 to 54	200 (16.7)	79 (16.7)		
55 to 64	130 (10.8)	54 (11.4)		
65 to 74	112 (9.3)	48 (10.1)		
75 and older	91 (7.6)	39 (8.2)		
Respondent's race:			0.763	2
White	1030 (84.4)	406 (83.2)		
Black		62 (12.7)		
Another race	137 (11.2)	20 (4.1)		
	53 (4.3)			

Table 5. (continued...)

Respondent's level of education:			0.128	4
less than high school	214 (17.4)	88 (18.0)		
high school graduate	413 (33.5)	164 (33.5)		
some college	331 (26.9)	129 (26.3)		
college graduate	189 (15.3)	76 (15.5)		
post graduate	85 (6.9)	33 (6.7)		
Household income:			10.079 ^a	6
\$12,000 or less	45 (4.9)	18 (5.0)		
\$12,001 to 20,000	75 (8.1)	28 (7.8)		
\$20,001 to 30,000	142 (15.4)	39 (10.8)		
\$30,001 to 50,000	275 (29.7)	96 (26.6)		
\$50,001 to 75,000	213 (23.0)	89 (24.7)		
\$75,001 to 100,000	99 (10.7)	50 (13.9)		
\$100,001 or more	76 (8.2)	41 (11.4)		
Respondent's sex:			0.119	1
Male	597 (47.9)	236 (46.8)		
Female	650 (52.1)	268 (53.2)		

^a Cases weighted by LYMEWT.

^b Yates continuity correction used for 2x2 tables.

^c Connecticut, Delaware, New Jersey, New York, Pennsylvania, and Rhode Island.

* $p < 0.25$, ** $p < 0.05$, *** $p < 0.01$, **** $p < 0.001$

Table 6. Frequencies regarding knowledge, attitudes, and practices regarding ticks and Lyme disease by sample.

Variable	Number (%)		
	National (n=1750) ^m	National excluding six high incidence Lyme disease states (n=1247) ⁿ	Six high incidence Lyme disease states (n=503) ^o
Know what ticks are	1661 (94.9)	1189 (95.3)	467 (92.8)
Saw ticks last summer	782 (47.1)	565 (47.5)	216 (46.3)
In respondent's state	613 (78.5)	504 (89.3)	167 (77.3)
Somewhat to very concerned to be bitten by ticks	599 (52.5)	420 (51.0)	184 (58.2)

^mCases weighted by WT.

ⁿCases weighted by LYMEWT.

^oCases weighted by LYMEWT.

Table 6. (continued...)

Did anything to avoid ticks	455 (39.8)	310 (37.7)	156 (49.4)
Used repellent to avoid bites	186 (41.0)	129 (41.7)	62 (40.0)
Used repellent on skin	143 (76.8)	97 (75.4)	51 (80.7)
Often on skin	56 (38.9)	38 (39.3)	21 (38.4)
Used repellent on clothes	137 (73.5)	95 (73.6)	46 (73.5)
Often on clothes	46 (33.5)	31 (33.1)	14 (31.4)
Wore long sleeves and pants	260 (57.2)	167 (54.1)	106 (68.6)
Often wore long sleeves and pants	140 (53.9)	90 (53.6)	58 (55.1)
Tucked socks into pants or boots	186 (41.0)	113 (36.8)	85 (54.3)
Often tucked socks into pants or boots	97 (52.0)	57 (50.4)	47 (55.3)
Stayed away from woods or grass	234 (51.4)	156 (50.3)	84 (53.7)
Often stayed away from woods or grass	143 (61.1)	91 (58.5)	58 (69.0)
Did anything else to avoid ticks or prevent being bitten	133 (29.6)	96 (31.3)	36 (23.1)
To remove attached tick, would use:			
Tweezers (1 st choice offered)	224 (38.4)	156 (37.2)	70 (44.6)
Hot match	127 (21.8)	97 (23.0)	24 (15.1)
Both	22 (3.8)	17 (4.0)	4 (2.8)
Something else	169 (28.9)	124 (29.5)	41 (26.2)
To remove attached tick, would use:			
Hot match (1 st choice offered)	97 (17.4)	80 (19.8)	85 (53.7)
Tweezers	234 (41.8)	158 (39.2)	11 (7.2)
Both	16 (2.9)	12 (2.9)	5 (3.1)
Something else	184 (33.0)	134 (33.3)	47 (30.0)
Staying away from woods or grass is very effective	1084 (65.3)	767 (64.5)	323 (69.3)
Using insect repellent is very effective	330 (19.9)	223 (18.8)	116 (24.9)
Wearing long pants/sleeves is very effective	495 (29.8)	326 (27.4)	196 (41.9)
Tucking socks into pants or boots is very effective	693 (41.7)	475 (39.9)	233 (49.9)

Table 6. (continued...)

Insect repellent used contained chemical DEET			
Yes	125 (15.8)	90 (15.6)	38 (19.0)
No	147 (18.6)	107 (18.5)	37 (18.2)
Don't know/Not sure	516 (65.5)	381 (65.9)	126 (62.7)
Has heard about Lyme disease	1507 (86.4)	1058 (85.1)	467 (92.7)
From where have you heard the most?			
TV	561 (37.2)	400 (37.8)	167 (35.7)
Radio	24 (1.6)	17 (1.6)	7 (1.4)
Newspapers	285 (18.9)	196 (18.5)	99 (21.1)
Magazines	223 (14.8)	160 (15.1)	62 (13.2)
Doctors	103 (6.9)	73 (6.9)	30 (6.5)
Somewhere else	295 (19.5)	200 (18.9)	99 (21.3)
Don't know/Remember	17 (1.1)	13 (1.2)	3 (0.7)
Knows someone who has had Lyme disease	341 (22.6)	198 (18.6)	198 (42.3)
Knows how someone gets Lyme disease	1168 (77.4)	819 (77.3)	366 (78.3)
R specified "tick" (open-ended)	1138 (97.4)	na	na
Lyme disease is extremely serious illness	362 (24.0)	255 (24.1)	113 (24.3)
Lyme disease is extremely serious illness for children (asked of respondents with children)	266 (52.3)	186 (53.1)	83 (49.6)

Table 6. (continued...)

If a safe and effective vaccine to prevent Lyme disease were available, and <u>not</u> covered by your health plan, would you get it: ^P			
at \$50 cost			
Yes	224 (34.8)	137 (30.4)	106 (52.2)
No	356 (55.4)	265 (58.9)	85 (41.9)
Don't know	63 (9.8)	48 (10.7)	12 (5.9)
at \$100 cost			
Yes	275 (39.4)	191 (38.4)	87 (42.4)
No	386 (55.3)	282 (56.7)	103 (50.2)
Don't know	37 (5.3)	24 (4.8)	15 (7.3)
at \$50 cost and 50% effectiveness			
Yes	80 (77.7)	48 (75.0)	40 (81.6)
No	15 (14.6)	10 (15.6)	7 (14.3)
Don't know	8 (7.8)	6 (9.4)	2 (4.1)
at \$50 cost and 75% effectiveness			
Yes	84 (69.4)	50 (68.5)	40 (70.2)
No	28 (23.1)	18 (24.7)	12 (21.1)
Don't know	9 (7.4)	5 (6.8)	5 (8.8)
at \$100 cost and 50% effectiveness			
Yes	93 (69.9)	62 (70.5)	34 (72.3)
No	30 (22.6)	20 (22.7)	9 (19.1)
Don't know	10 (7.5)	6 (6.8)	4 (8.5)
at \$100 cost and 75% effectiveness			
Yes	92 (65.7)	68 (66.7)	25 (64.1)
No	38 (27.1)	27 (26.5)	11 (28.2)
Don't know	10 (7.1)	7 (6.9)	3 (7.7)

^PRespondents had an equal probability of being asked one of following combinations of vaccine cost and vaccine effectiveness: \$50 and 50% or 75%; \$100 and 50% or 75%.

Table 7. Crude odds ratios for self-reported behavior to prevent tick bites and selected variables, United States, 1998.

Variable	U.S. (n=1750) ¹		U.S. excluding LD states (n=1347) ²		LD states (n=503) ³	
	N (%)	OR (95% CI) ⁴	N (%)	OR (95% CI)	N (%)	OR (95% CI)
Saw ticks last summer:						
- Yes	394 (86.6)	4.9 (3.6, 6.8)****	272 (88.0)	5.6 (3.8, 8.2)****	127 (81.4)	3.5 (2.1, 5.9)****
- No/not Sure	61 (13.4)		37 (12.0)		29 (18.6)	
Somewhat to very concerned to be bitten by ticks:						
- Yes	367 (80.7)	8.3 (6.3, 11.1)****	117 (75.0)	4.3 (2.7, 7.0)****	254 (81.9)	9.7 (6.9, 13.7)****
- No	88 (19.3)		39 (25.0)		56 (18.1)	
Staying away from woods is somewhat to very effective:						
- Yes	431 (95.5)	1.7 (1.0, 3.0)**	291 (95.1)	1.5 (0.8, 2.8)*	152 (98.1)	4.5 (1.3, 16.2)*
- No	20 (4.4)		15 (4.9)		3 (1.9)	
Using insect repellent is somewhat or very effective:						
- Yes	328 (80.0)	2.0 (1.5, 2.6)****	217 (78.6)	1.9 (1.3, 2.6)***	125 (84.5)	2.1 (1.3, 3.7)**
- No	82 (20.0)		59 (21.4)		23 (15.5)	
Wearing long sleeves and long pants is somewhat to very effective:						
- Yes	378 (83.6)	2.0 (1.4, 2.6)****	250 (81.7)	1.8 (1.3, 2.6)***	142 (91.6)	2.4 (1.2, 4.8)**
- No	74 (16.4)		56 (18.3)		13 (8.4)	
Tucking socks into pants or boots is somewhat to very effective:						
- Yes	389 (86.4)	1.4 (1.0, 1.9)*	259 (84.9)	1.3 (0.9, 1.9)	144 (92.9)	1.9 (0.9, 4.1)*
- No	61 (13.6)		46 (15.1)		11 (7.1)	
Insect repellent used contained chemical DEET:						
- Yes	71 (22.4)	1.9 (1.2, 2.9)***	52 (23.3)	2.2 (1.3, 3.6)***	22 (21.8)	1.1 (0.5, 2.5)
- No	246 (77.6)		171 (76.7)		79 (78.2)	
Heard about Lyme disease:						
- Yes	435 (95.8)	4.1 (2.5, 6.8)****	293 (95.1)	3.9 (2.2, 6.8)****	155 (99.4)	12.7 (1.6, 98.5)**
- No	19 (4.2)		15 (4.9)		1 (0.6)	
Knows someone who has had Lyme disease:						
- Yes	156 (35.9)	2.0 (1.5, 2.6)****	82 (28.1)	1.7 (1.2, 2.5)**	98 (63.6)	2.4 (1.5, 3.8)****
- No	278 (64.1)		210 (71.9)		56 (36.4)	
Knows how someone gets Lyme:						
- Yes	379 (87.3)	1.7 (1.2, 2.4)**	250 (85.6)	1.4 (1.0, 2.1)*	145 (93.5)	4.0 (1.9, 8.6)****
- No	55 (12.7)		42 (14.4)		10 (6.5)	
Lyme disease is very to extremely serious illness:						
- Yes	347 (82.6)	1.5 (1.1, 2.0)*	239 (84.4)	1.8 (1.2, 2.7)**	114 (75.5)	0.7 (0.4, 1.2)*
- No	73 (17.4)		43 (15.2)		37 (24.5)	

Table 7. (continued...)

Variable	U.S. (n=1750) ¹		U.S. excluding LD states (n=1247) ²		LD states (n=503) ³	
	N (%)	OR (95% CI) ⁴	N (%)	OR (95% CI)	N (%)	OR (95% CI)
Lyme disease is very to extremely serious illness for children (asked of respondents with children):						
- Yes						
- No	171 (96.6) 6 (3.4)	2.9 (1.1, 7.6)**	113 (98.3) 2 (1.7)	6.3 (1.4, 28.7)**	66 (91.7) 6 (8.3)	0.3 (0.0, 2.6)
Perceived likelihood respondent will ever get Lyme disease (0=never, 100=definitely):						
0-50	369 (87.2)	0.4 (0.3, 0.7)****	248 (87.3)	0.4 (0.2, 0.7)****	132 (86.3)	0.7 (0.3, 1.5)
51-100	54 (12.8)		36 (12.7)		21 (13.7)	
Perceived likelihood respondent's children will ever get Lyme disease (0=never, 100=definitely):						
0-50	128 (76.2)	0.4 (0.2, 0.8)***	83 (76.9)	0.4 (0.2, 0.8)**	51 (75.0)	0.7 (0.3, 2.0)
51-100	40 (23.8)		25 (23.1)		17 (25.0)	
R would buy Lyme disease vaccine: ⁵						
at \$50 cost						
- Yes	90 (50.6)	1.7 (1.1, 2.5)***	57 (47.9)	1.9 (1.2, 3.2)***	37 (56.9)	0.8 (0.4, 1.7)
- No	88 (49.4)		62 (52.1)		28 (43.1)	
at \$100 cost						
- Yes	113 (59.2)	3.1 (2.1, 4.6)****	77 (58.3)	3.1 (2.0, 5.0)****	40 (64.5)	3.5 (1.7, 7.6)***
- No	78 (40.8)		55 (41.7)		22 (35.5)	
R reads newspaper regularly:						
- Yes	341 (74.9)	1.5 (1.2, 2.0)***	230 (74.4)	1.5 (1.1, 2.1)**	121 (78.1)	1.6 (0.9, 2.7)*
- No	114 (25.1)		79 (25.6)		34 (21.9)	
Reads newspaper more than 4 days/wk:						
- Yes	233 (69.1)	0.8 (0.5, 1.0)*	153 (67.4)	0.67 (0.5, 1.0)**	91 (75.2)	1.1 (0.6, 1.9)
- No	104 (30.9)		74 (32.6)		30 (24.8)	
Has dogs only as pets:						
- Yes	142 (52.2)	2.0 (1.5, 2.7)****	101 (56.4)	2.3 (1.6, 3.2)****	41 (39.4)	1.6 (0.9, 2.7)*
- No	130 (47.8)		78 (43.6)		63 (60.6)	
Has cats only as pets:						
- Yes	77 (37.2)	2.9 (2.0, 4.3)****	47 (37.6)	3.1 (1.9, 5.1)****	35 (35.7)	2.2 (1.2, 4.1)**
- No	130 (62.8)		78 (62.4)		63 (64.3)	
Has both dogs and cats as pets:						
- Yes	106 (44.9)	2.2 (1.6, 3.1)****	83 (51.6)	2.7 (1.8, 3.9)****	37 (21.3)	1.7 (0.8, 3.6)
- No	130 (55.1)		78 (48.4)		63 (78.8)	
Type of home:						
- Single house OR	345 (77.4)	1.4 (1.1, 1.9)**	246 (80.1)	1.6 (1.1, 2.2)**	98 (67.6)	1.2 (0.7, 1.9)
- Row-Townhouse-Duplex - Apt/Condo	101 (22.6)		61 (19.9)		47 (32.4)	
Location where R lives:						
- City	109 (47.6)	0.8 (0.6, 1.1)	76 (52.4)	0.9 (0.6, 1.3)	36 (35.6)	0.8 (0.4, 1.4)
- Suburb	120 (52.4)		69 (47.6)		65 (64.4)	
Location where R lives:						
- Small town	86 (39.6)	0.6 (0.4, 0.8)***	62 (38.5)	0.6 (0.4, 1.0)**	22 (45.8)	0.5 (0.3, 1.2)*
- Rural area	131 (60.4)		99 (61.5)		26 (54.2)	

Table 7. (continued...)

Variable	U.S. (n=1750) ¹		U.S. excluding LD states (n=1247) ²		LD states (n=503) ³	
	N (%)	OR (95% CI) ⁴	N (%)	OR (95% CI)	N (%)	OR (95% CI)
Location where R lives:						
- City	109 (45.5)	0.6 (0.4, 0.8)***	76 (43.4)	0.6 (0.4, 0.9)**	22 (45.3)	0.6 (0.3, 1.1)*
- Rural area	131 (54.6)		99 (56.6)		26 (54.2)	
Location where R lives:						
- Suburb	120 (58.3)	1.3 (0.9, 1.8)*	69 (52.7)	1.1 (0.7, 1.7)	65 (74.7)	2.0 (1.0, 3.7)
- Small town	86 (41.7)		62 (47.3)		22 (25.3)	
Respondent's race:						
- White	398 (89.6)	1.6 (1.1, 2.4)**	275 (90.5)	1.8 (1.2, 2.9)**	129 (90.2)	1.1 (0.6, 2.1)
- Black or other	46 (10.4)		29 (9.5)		20 (13.4)	
Household income:						
- Less than \$12,000 to \$50,000	177 (51.3)	0.8 (0.6, 1.1)*	128 (54.0)	0.9 (0.7, 1.2)	49 (41.2)	0.8 (0.5, 1.4)
- \$50,001 or more	168 (48.7)		109 (46.0)		70 (58.8)	
Respondent's age:						
- 18 to 44	262 (59.5)	1.1 (0.8, 1.4)	179 (59.9)	1.1 (0.8, 1.4)	91 (60.7)	1.5 (1.0, 2.4)*
- 45 and older	178 (46.5)		120 (40.1)		59 (39.3)	

1. Cases weighted by WT

2. Non-LD states excluded Connecticut, Delaware, New Jersey, New York, Pennsylvania, and Rhode Island; cases weighted by LYMEWT

3. LD states included Connecticut, Delaware, New Jersey, New York, Pennsylvania, and Rhode Island; cases weighted by LYMEWT

4. 95% confidence interval.

5. Respondents had an equal probability of vaccine cost being either \$50 or \$100

*p<0.25, **p<0.05, ***p<0.01, ****p<0.001.

Table 8. Logistic regression analysis predicting an index measure and several self-reported behaviors to prevent tick bites, United States, 1998.

Independent Variables	Sample ¹	Individual Behaviors (OR, 95% CI) ²							
		Used repellent to avoid bites	Used repellent on skin	Used repellent on clothes	Wore long sleeves and long pants	Tucked socks into pants or boots	Stayed away from woods or grass	Did anything else to avoid ticks	Tick bite prevention index Measure ³
R ⁴ saw ticks last summer in own state and elsewhere - Yes = 1 - No = 0	I	1.20 (0.64, 2.24)	0.96 (0.50, 1.84)	1.04 (0.54, 1.98)	1.76 (0.93, 3.35)	3.21 (1.18, 7.46)**	2.18 (1.07, 4.43)*	2.50 (0.91, 6.90)	2.59 (1.45, 4.65)***
	II	1.39 (0.61, 3.21)	0.91 (0.39, 2.16)	0.95 (0.41, 2.21)	1.78 (0.74, 4.30)	3.77 (1.14, 12.52)*	3.05 (1.13, 8.23)*	2.89 (0.91, 6.90)	2.94 (1.36, 6.38)**
	III	0.91 (0.29, 2.79)	0.10 (0.31, 3.18)	2.32 (0.64, 8.41)	2.07 (0.65, 6.58)	2.14 (0.57, 8.12)	0.94 (0.28, 3.18)	8.73 (0.82, 92.78)	2.48 (0.67, 9.14)
R knew someone who has had Lyme disease - Yes - No	I	1.14 (0.68, 1.90)	0.91 (0.54, 1.54)	1.02 (0.61, 1.71)	0.79 (0.47, 1.32)	1.39 (0.80, 2.43)	1.23 (0.72, 2.11)	1.64 (0.88, 3.04)	1.26 (0.74, 2.15)
	II	0.81 (0.42, 1.56)	0.55 (0.27, 1.10)	0.78 (0.40, 1.49)	0.42 (0.21, 0.83)**	0.75 (0.36, 1.58)	0.89 (0.44, 1.78)	1.69 (0.80, 3.57)	0.73 (0.37, 1.44)
	III	2.82 (1.00, 7.95)*	2.13 (0.73, 6.17)	1.99 (0.66, 6.04)	1.36 (0.49, 3.72)	4.35 (1.36, 13.91)**	4.50 (1.46, 13.87)***	0.76 (0.14, 4.16)	4.09 (1.33, 12.56)**
R knows how someone gets Lyme disease: - Yes - No	I	2.15 (0.91, 5.08)	1.47 (0.61, 3.53)	2.53 (0.95, 6.71)	1.61 (0.72, 3.62)	0.26 (0.11, 0.62)**	1.62 (0.68, 3.81)	1.03 (0.33, 3.15)	1.15 (0.54, 2.46)
	II	1.78 (0.60, 5.32)	1.06 (0.35, 3.26)	2.25 (0.67, 7.60)	0.76 (0.27, 2.10)	0.98 (0.02, 0.27)***	1.16 (0.39, 3.44)	0.84 (0.21, 3.42)	0.53 (0.20, 1.39)
	III	2.19 (0.49, 9.79)	1.85 (0.42, 8.21)	2.18 (0.37, 12.79)	13.92 (2.44, 79.33)**	5.70 (0.88, 36.70)	1.79 (0.34, 9.59)	7.36 (0.46, 117.96)	22.09 (3.57, 136.54)***
R believes Lyme disease is a somewhat to extremely serious illness - Yes - No	I	0.82 (0.44, 1.56)	0.91 (0.47, 1.82)	1.14 (0.58, 2.22)	1.81 (0.90, 3.63)	8.25 (2.62, 26.04)***	0.72 (0.36, 1.43)	0.96 (0.42, 2.16)	1.11 (0.60, 2.07)
	II	1.37 (0.60, 3.13)	1.72 (0.68, 4.36)	2.22 (0.89, 5.60)	5.08 (1.75, 14.70)**	29.73 (4.12, 214.61)***	1.13 (0.45, 2.79)	1.56 (0.54, 4.53)	2.56 (1.14, 5.73)*
	III	0.39 (0.12, 1.25)	0.38 (0.11, 1.26)	0.27* (0.08, 0.90)	0.46 (0.13, 1.55)	4.93 (1.10, 22.14)*	0.41 (0.12, 1.41)	0.05 (0.01, 0.43)**	0.10 (0.02, 0.50)**

Table 8. (continued...)

Independent Variables	Sample ¹	Individual Behaviors (OR, 95% CI) ²									
		Used repellent to avoid bites	Used repellent on skin	Used repellent on clothes	Wore long sleeves and long pants	Tucked socks into pants or shorts	Stayed away from woods or grass	Did anything else to avoid ticks	Tick bite prevention index		
R is somewhat to very concerned to be bitten by ticks	I	5.72 (3.23, 10.14)***	5.09 (2.72, 9.52)***	3.30 (1.83, 5.94)***	5.33 (2.95, 9.62)***	6.90 (3.22, 14.79)***	7.48 (3.66, 15.31)***	4.61 (1.92, 11.06)***	7.48 (4.46, 12.55)***		
	II	8.04 (3.81, 16.94)***	6.06 (2.70, 13.59)***	4.80 (2.22, 10.18)***	6.66 (3.04, 14.62)***	9.84 (3.26, 29.69)***	13.21 (4.77, 36.61)***	3.19 (1.16, 8.58)*	11.23 (5.78, 21.76)***		
	III	1.98 (0.69, 5.67)	3.21* (1.04, 10.09)	1.01 (0.33, 3.09)	5.16** (1.75, 15.24)	8.31** (2.08, 31.25)	2.20 (0.71, 6.88)	89.64** (4.22, 1905.55)	4.42* (1.27, 15.31)		
R perceived likelihood he/she will ever get Lyme disease.	I	2.66 (1.21, 5.85)**	2.08 (0.94, 4.60)*	2.44 (1.13, 5.26)*	1.90 (0.88, 4.09)	0.92 (0.38, 2.21)	0.76 (0.31, 1.86)	2.02 (0.86, 4.74)	2.25 (0.94, 5.37)		
	II	3.59 (1.32, 9.77)**	2.56 (0.94, 7.01)	3.00 (1.14, 7.91)*	1.73 (0.63, 4.76)	0.70 (0.20, 2.49)	0.62 (0.18, 2.13)	2.80 (0.94, 8.26)	2.20 (0.74, 6.55)		
	III	1.08 (0.39, 4.04)	1.06 (0.28, 4.07)	1.57 (0.41, 6.00)	1.60 (0.42, 6.06)	0.82 (0.20, 3.46)	1.05 (0.29, 3.76)	0.55 (0.09, 3.43)	1.86 (0.23, 15.19)		
R believes staying away from woods is somewhat to very effective.	I	0.44 (0.15, 1.25)	0.32 (0.11, 0.95)*	0.88 (0.30, 2.58)	1.29 (0.39, 4.25)	2.19 (0.57, 8.43)	1.54 (0.43, 5.54)	4.67 (0.64, 34.39)	1.04 (0.37, 2.91)		
	II	0.42 (0.12, 1.51)	0.30 (0.08, 1.06)	1.12 (0.31, 4.05)	1.41 (0.31, 6.39)	2.58 (0.40, 16.52)	2.23 (0.42, 11.78)	4.23 (0.39, 45.43)	1.00 (0.28, 3.53)		
	III	0.17 (0.03, 4.96)	0.19(0.01, 3.28)	0.21 (0.01, 3.28)	1.75 (0.15, 20.35)	3.11 (0.25, 36.87)	2.06 (0.19, 22.47)	9.58 (0.06, 1492.63)	3.50 (0.27, 45.21)		
R believes using insect repellent is somewhat to very effective.	I	5.61 (2.97, 10.60)***	4.42 (2.23, 8.76)***	3.50 (1.83, 6.69)***	6.52 (0.30, 0.89)**	0.60 (0.33, 1.09)	0.69 (0.39, 1.23)	1.22 (0.61, 2.41)	1.45 (0.85, 2.48)		
	II	6.90 (3.07, 15.51)***	5.57 (2.31, 13.40)***	4.07 (1.83, 9.06)***	4.42 (0.21, 0.85)**	0.51 (0.24, 1.08)	0.62 (0.30, 1.27)	1.14 (0.50, 2.62)	1.46 (0.75, 2.87)		
	III	5.96 (1.70, 20.77)**	5.45 (1.36, 21.82)*	5.39 (1.38, 21.01)**	1.30 (0.41, 3.55)	1.46 (0.45, 4.73)	0.84 (0.27, 2.58)	1.51 (0.29, 7.85)	2.99 (0.61, 10.27)		

Table 8. (continued...)

Independent Variables	Sample ¹	Individual Behaviors (OR, 95% CI) ²							
		Used repellent to avoid bites	Used repellent on skin	Used repellent on clothes	Wore long sleeves and long pants	Tucked socks into pants or boots	Stayed away from woods or grass	Did anything else to avoid ticks	Tick bite prevention index Measure ¹
R believes wearing long pants/sleeves somewhat to very effective	I	0.84 (0.45, 1.58)	1.87 (0.93, 3.76)	1.04 (0.55, 1.97)	6.60 (3.05, 14.28)***	2.90 (1.33, 6.32)**	2.65 (1.25, 5.63)**	1.03 (0.48, 2.19)	1.66 (0.89, 3.09)
	II - Yes	0.75 (0.35, 1.62)	2.07 (0.89, 4.81)	0.98 (0.46, 2.08)	10.31 (3.74, 28.38)***	4.09 (1.49, 11.23)**	2.94 (1.17, 7.38)*	1.45 (0.57, 3.65)	1.51 (0.71, 3.23)
	III - No	1.23 (0.24, 6.23)	1.75 (0.27, 11.22)	1.16 (0.20, 6.77)	1.23 (0.27, 5.57)	0.50 (0.11, 2.40)	0.83 (0.16, 4.34)	0.11 (0.01, 0.90)*	0.80 (0.15, 4.26)
R knows repellent used contains the chemical DEET:	I	1.74 (0.99, 3.05)*	1.67 (0.94, 2.94)	2.06 (1.19, 3.57)**	0.89 (0.50, 1.59)	0.77 (0.41, 1.48)	0.88 (0.48, 1.62)	1.83 (0.97, 3.46)	1.81 (0.97, 3.36)
	II - Yes = 1	1.66 (0.83, 3.31)	1.98 (0.98, 3.99)	1.88 (0.96, 3.70)	1.27 (0.61, 2.62)	0.88 (0.40, 1.96)	1.05 (0.50, 2.18)	1.90 (0.87, 4.12)	2.29 (1.04, 5.01)*
	III - No/not sure = 0	2.87 (0.95, 8.68)	1.38 (0.46, 4.15)	4.41 (1.48, 13.17)**	0.28 (0.09, 0.87)*	0.44 (0.12, 1.66)	0.26 (0.07, 0.97)*	5.39 (1.07, 27.06)*	0.81 (0.22, 2.97)
R reads newspaper regularly:	I	1.41 (0.81, 2.45)	1.04 (0.59, 1.82)	1.10 (0.63, 1.91)	1.79 (1.04, 3.09)*	1.12 (0.63, 2.02)	1.93 (1.05, 3.53)*	1.37 (0.69, 2.74)	1.62 (0.95, 2.78)
	II - Yes = 1	1.34 (0.68, 2.67)	1.00 (0.50, 2.02)	1.04 (0.53, 2.06)	2.18 (1.07, 4.44)*	1.16 (0.54, 2.48)	2.04 (0.94, 4.41)	2.10 (0.85, 5.17)	2.07 (1.04, 4.13)*
	III - No = 0	1.94 (0.70, 5.40)	1.66 (0.59, 4.68)	1.32 (0.45, 3.85)	1.42 (0.50, 4.02)	0.70 (0.23, 2.17)	2.36 (0.78, 7.15)	0.14 (0.03, 0.67)**	0.56 (0.16, 1.95)
R has dogs and/or cats:	I	1.73 (1.01, 2.96)*	1.46 (0.83, 2.55)	1.18 (0.68, 2.04)	1.66 (0.97, 2.86)	2.08 (1.11, 3.90)*	0.79 (0.46, 1.38)	1.56 (0.77, 3.16)	2.12 (1.26, 3.56)**
	II - Yes	2.20 (1.09, 4.47)*	1.60 (0.77, 3.33)	1.37 (0.68, 2.79)	1.72 (0.83, 3.59)	2.02 (0.85, 4.81)	0.67 (0.32, 1.39)	1.76 (0.69, 4.49)	2.19 (1.12, 4.29)*
	III - No pets	0.99 (0.41, 2.34)	1.22 (0.50, 2.97)	0.75 (0.30, 1.89)	1.68 (0.69, 4.09)	3.20 (1.15, 8.92)*	0.97 (0.40, 2.35)	1.11 (0.28, 4.36)	2.17 (0.71, 6.43)

Table 8. (continued...)

Independent Variables	Sample ¹	Individual Behaviors (OR, 95% CI) ²									
		Used repellent to avoid bites	Used repellent on skin	Used repellent on clothes	Wore long sleeves and long pants	Tucked socks into pants or boots	Stayed away from woods or grass	Did anything else to avoid ticks	Tick bite prevention index Measure ³		
Marital status: • Married = 1 • Not married = 0	I	0.60 (0.36, 1.00)*	0.69 (0.41, 1.17)	1.39 (0.82, 2.35)	0.64 (0.38, 1.07)	1.43 (0.79, 2.60)	0.70 (0.41, 1.20)	1.09 (0.58, 2.07)	0.47 (0.27, 0.82)**		
	II	0.53 (0.28, 1.01)*	0.64 (0.34, 1.21)	1.47 (0.77, 2.79)	0.50 (0.26, 0.96)*	1.44 (0.68, 3.05)	0.61 (0.31, 1.18)	1.04 (0.48, 2.24)	0.45 (0.23, 0.90)*		
	III	0.89 (0.32, 2.51)	0.78 (0.27, 2.23)	1.49 (0.47, 4.69)	0.86 (0.30, 2.43)	0.88 (0.26, 2.97)	0.99 (0.35, 2.83)	1.53 (0.20, 11.55)	0.51 (0.14, 1.89)		
Type of home: • Single family house = 1 • Other = 0 (Row) Townhouse-Duplex Apartment/Condo	I	1.32 (0.72, 2.42)	1.03 (0.56, 1.91)	0.90 (0.49, 1.67)	0.99 (0.55, 1.80)	0.44 (0.23, 0.85)**	0.70 (0.40, 1.29)	1.15 (0.52, 2.52)	0.89 (0.47, 1.66)		
	II	1.70 (0.74, 3.89)	1.24 (0.54, 2.89)	1.34 (0.58, 3.09)	1.39 (0.61, 3.15)	0.57 (0.24, 1.38)	0.74 (0.32, 1.68)	1.22 (0.42, 3.55)	0.86 (0.36, 2.04)		
	III	1.13 (0.44, 2.88)	1.16 (0.45, 2.98)	0.44 (0.16, 1.20)	1.27 (0.51, 3.20)	0.75 (0.27, 2.12)	0.77 (0.30, 1.98)	1.02 (0.21, 4.92)	2.64 (0.84, 8.26)		
Location where R lives: • City or suburb = 1 • Small town or rural area = 0	I	1.07 (0.66, 1.73)	1.34 (0.81, 2.22)	1.07 (0.65, 1.74)	0.76 (0.46, 1.24)	1.49 (0.66, 2.58)	0.53 (0.32, 0.90)*	2.10 (1.13, 3.90)*	1.02 (0.62, 1.67)		
	II	1.23 (0.67, 2.25)	1.99 (1.03, 3.84)*	1.08 (0.59, 1.98)	1.18 (0.61, 2.27)	2.17 (1.05, 4.52)*	0.53 (0.27, 1.03)	3.34 (1.49, 7.53)**	1.26 (0.67, 2.30)		
	III	0.54 (0.22, 1.34)	0.47 (0.18, 1.20)	0.91 (0.35, 2.35)	0.40 (0.16, 1.08)*	1.21 (0.45, 3.27)	0.62 (0.24, 1.59)	0.58 (0.14, 2.33)	0.54 (0.19, 1.55)		
Respondent's race: • White = 1 • Non-white = 0	I	0.99 (0.41, 2.39)	1.41 (0.55, 3.59)	0.87 (0.35, 2.13)	1.44 (0.59, 3.48)	0.43 (0.17, 1.12)	0.50 (0.21, 1.17)	0.69 (0.20, 2.29)	0.80 (0.34, 1.89)		
	II	0.86 (0.28, 2.64)	1.33 (0.41, 4.32)	0.83 (0.27, 2.55)	2.27 (0.67, 7.62)	0.61 (0.17, 2.17)	0.49 (0.17, 1.44)	0.40 (0.09, 1.75)	0.88 (0.29, 2.71)		
	III	1.17 (0.28, 4.99)	1.65 (0.35, 7.69)	1.33 (0.35, 6.93)	0.58 (0.13, 2.63)	0.20 (0.03, 1.13)	0.61 (0.13, 2.80)	ns	1.10 (0.20, 6.07)		

Table 8. (continued...)

- 1 OR = adjusted odds ratio, CI=confidence interval
- 2 I = U.S. sample, cases weighted by WT; II = U.S. sample excluding Connecticut, Delaware, New Jersey, New York, Pennsylvania, and Rhode Island, cases weighted by LYMEWT, III = Over-sampled states of Connecticut, Delaware, New Jersey, New York, Pennsylvania, and Rhode Island, cases weighted by LYMEWT
- 3. The index measure for the prevention of tick bites equals the sum of seven behavioral variables (where respondent stated they had performed the action coded no = 0 and yes = 1) plus the sum of five frequency of action variables (where respondent stated they had performed the action "occasionally vs. sometimes vs. often," coded 0 and 1 respectively) that yielded an action score (range 0 to 12). The index measure was dichotomized and coded such that "action" equaled scores greater than or equal to 1 and no action equaled scores of 0

§R = respondent

*p<0.05, **p<0.01, ***p<0.001

Table 9. Frequencies regarding knowledge, attitudes, and practices regarding mosquitoes and encephalitis by sample.

Variable	Number (%)		
	U.S. (n=1750) ^a	U.S. excluding six NE states (n=1247) ^f	NE states (n=503) ^e
Saw mosquitoes last summer	1341 (76.8)	969 (77.9)	364 (72.3)
In respondent's state	965 (71.9)	699 (72.1)	257 (70.6)
Somewhat to very concerned to be bitten by mosquitoes	576 (43.0)	417 (43.1)	151 (41.8)
Did anything to avoid mosquitoes	922 (68.8)	682 (70.6)	224 (61.7)
Used repellent to avoid bites	742 (80.5)	547 (80.2)	185 (82.5)
Used repellent on skin	679 (91.4)	501 (91.7)	166 (90.0)
Often on skin	177 (26.1)	135 (27.0)	33 (20.0)
Used repellent on clothes	437 (58.9)	327 (59.8)	103 (55.7)
Often on clothes	118 (27.1)	91 (27.8)	22 (21.3)
Stayed indoors late afternoon and evenings	386 (41.9)	289 (42.5)	85 (38.2)
Often stayed indoors	184 (47.6)	142 (49.2)	31 (36.0)
Wore long sleeves and pants	383 (41.6)	289 (42.4)	85 (38.1)
Often wore long sleeves and pants	177 (46.4)	135 (46.9)	34 (39.6)
Did anything else to avoid mosquitoes	251 (27.5)	183 (26.9)	62 (28.5)
Using insect repellent is somewhat to very effective	1479 (84.5)	1058(84.8)	420 (83.4)
Staying indoors late afternoon and evening is somewhat to very effective	1358 (77.6)	977 (78.3)	370 (73.5)
Wearing long pants/sleeves is somewhat to very effective	1393 (79.6)	994 (79.7)	398 (79.1)

^aCases weighted by WT.

^eCases weighted by NEWT.

^fCases weighted by NEWT.

Table 9. (continued...)

From where have you heard the most?			
TV	344 (34.6)	251 (35.4)	94 (32.9)
Radio	11 (1.1)	8 (1.2)	4 (1.3)
Newspapers	154 (15.6)	107 (15.1)	50 (17.6)
Magazines	132 (13.3)	90 (12.8)	38 (13.5)
Doctors	81 (8.2)	62 (8.7)	15 (5.3)
Somewhere else	224 (22.6)	160 (22.6)	66 (23.2)
Knows someone who has had encephalitis	154 (15.6)	111 (15.7)	44 (15.3)
Knows how someone gets encephalitis	438 (44.1)	320 (45.2)	115 (40.3)
Encephalitis is extremely serious illness	348 (35.1)	240 (33.9)	113 (39.5)
Encephalitis is extremely serious illness for your children (asked of respondents with children)	141 (51.9)	100 (51.5)	42 (52.9)
On scale 0=never and 100=definitely, likelihood respondent will ever get encephalitis:			
0-50	824 (94.2)	588 (93.4)	240 (97.6)
51-100	51 (5.8)	41 (6.6)	6 (2.4)
On scale 0=never and 100=definitely, likelihood respondent's children will ever get encephalitis:			
0-50	218 (90.0)	159 (90.2)	58 (88.6)
51-100	24 (10.0)	17 (9.8)	7 (11.4)

Table 10. Crude odds ratios between self-reported behavior to prevent mosquito bites variable and selected variables, United States, 1998.

Variable	U.S. (n=1750) ¹		U.S. excluding LD states (n=1247) ²		LD states (n=503) ²	
	N (%)	OR (95% CI) ¹	N (%)	OR (95% CI)	N (%)	OR (95% CI)
Saw mosquitoes last summer in own state and elsewhere: Yes No	834 (90.7) 86 (9.3)	1.34 (0.92, 1.93)*	619 (91.0) 61 (9.0)	1.44 (0.93, 2.24)*	198 (88.4) 26 (11.6)	0.99 (0.51, 1.92)
Somewhat to very concerned to be bitten by mosquitoes: Yes No	501 (54.3) 421 (45.7)	5.35 (4.03, 7.09)****	363 (53.2) 319 (46.8)	4.92 (3.52, 6.87)****	131 (58.5) 93 (41.5)	8.31 (4.83, 14.31)****
Using insect repellent is somewhat to very effective: Yes No	829 (92.5) 67 (7.5)	2.01 (1.38, 2.94)****	618 (93.2) 45 (6.8)	2.34 (1.48, 3.69)****	196 (89.5) 23 (10.5)	1.33 (0.69, 2.58)
Staying indoors in late afternoon and evening somewhat to very effective: Yes No	776 (86.0) 126 (14.0)	1.95 (1.45, 2.62)****	579 (86.9) 87 (13.1)	2.02 (1.41, 2.89)****	178 (80.2) 44 (19.8)	1.57 (0.95, 2.58)*
Wearing long pants/sleeves somewhat to very effective: Yes No	740 (80.8) 176 (19.2)	0.86 (0.64, 1.17)	584 (80.8) 130 (19.2)	0.91 (0.64, 1.31)	178 (80.2) 44 (19.8)	0.65 (0.36, 1.16)*
It is somewhat to very likely that using insect repellent can make you sick: Yes No	402 (45.9) 473 (54.1)	1.23 (0.97, 1.57)*	291 (44.9) 357 (51.1)	1.29 (0.91, 1.63)*	106 (50.5) 104 (49.5)	1.42 (0.91, 2.20)*
It is somewhat to very likely that using insect repellent can make children sick (asked of respondents with children): Yes No	201 (57.9) 146 (42.1)	0.97 (0.65, 1.46)	142 (56.6) 109 (43.4)	0.91 (0.56, 1.48)	58 (63.7) 33 (36.3)	1.42 (0.69, 2.91)
Repellent used contained the chemical DEET: Yes No	120 (16.0) 631 (84.0)	0.72 (0.26, 1.97)	89 (16.1) 465 (83.9)	2.68 (0.35, 20.64)	32 (17.3) 153 (82.7)	0.25 (0.07, 0.87)**
Has heard about encephalitis: Yes No	549 (59.8) 369 (40.2)	1.27 (1.01, 1.61)**	401 (59.1) 278 (40.9)	1.28 (0.97, 1.69)*	148 (66.4) 75 (33.6)	1.46 (0.94, 2.25)*

Table 10. (continued...)

Variable	U.S. (n=1750) ¹		U.S. excluding LD states (n=1247) ²		LD states (n=503) ²	
	N (%)	OR (95% CI) ¹	N (%)	OR (95% CI)	N (%)	OR (95% CI)
Knows someone who has had encephalitis: Yes No	84 (15.4) 463 (84.6)	0.93 (2 0.61, 1.43)	61 (15.3) 338 (84.7)	0.94 (0.56, 1.57)	25 (16.8) 124 (83.2)	1.14 (0.54, 2.42)
Knows how someone gets encephalitis: Yes No	248 (45.1) 302 (54.9)	0.99 (0.73, 1.36)**	185 (46.3) 215 (53.8)	0.59 (0.22, 1.58)**	59 (39.9) 89 (60.1)	0.63 (0.57, 1.58)
Encephalitis is a somewhat to extremely serious illness: Yes No	432 (87.3) 63 (12.7)	1.66 (1.07, 2.58)	315 (87.3) 46 (12.7)	1.78 (1.05, 3.00)	118 (88.1) 16 (11.9)	1.35 (0.59, 3.10)
Encephalitis is extremely serious illness for your children (asked of respondents with children): Yes No	164 (93.7) 11 (6.3)	1.24 (0.33, 4.77)	120 (93.8) 8 (6.3)	1.25 (0.25, 6.26)	43 (93.5) 3 (6.5)	1.10 (0.11, 11.52)
On scale 0=never and 100=definitely, likelihood respondent will ever get encephalitis: 0-50 51-100	454 (94.6) 26 (5.4)	0.55 (0.22, 1.35)*	332 (93.8) 22 (6.2)	0.58 (0.22, 1.58)	122 (99.2) 1 (0.8)	0.63 (0.57, 0.71)
On scale 0=never and 100=definitely, likelihood respondent's children will ever get encephalitis: 0-50 51-100	156 (88.6) 20 (11.4)	0.67 (0.16, 2.01)	114 (88.4) 15 (11.6)	0.52 (0.11, 2.42)	41 (89.1) 5 (10.9)	0.77 (0.67, 0.90)
Reads newspaper four or more days per week: Yes No	443 (70.8) 183 (29.2)	0.70 (0.51, 0.97)**	325 (70.2) 138 (29.8)	0.67 (0.46, 1.00)*	37 (23.7) 156 (100)	0.92 (0.52, 1.63)
R has only dogs as pets: Yes No	260 (42.3) 356 (57.7)	1.49 (1.11, 1.20)***	196 (43.2) 258 (56.8)	1.50 (1.06, 2.12)**	56 (37.3) 84 (62.7)	1.35 (0.80, 2.27)
R has only cats as pets: Yes No	131 (27.0) 355 (73.0)	1.61 (1.10, 2.35)**	88 (17.3) 258 (74.6)	1.41 (0.89, 2.22)*	50 (34.7) 94 (65.3)	2.93 (1.51, 5.69)***
R has dogs and cats: Yes No	174 (32.9) 355 (57.1)	1.45 (1.04, 2.01)**	140 (35.2) 258 (64.8)	1.40 (0.96, 2.06)	22 (19.0) 94 (81.0)	1.29 (0.62, 2.68)

Table 10. (continued...)

Variable	U.S. (n=1750) ¹		U.S. excluding LD states (n=1247) ²		LD states (n=503) ²	
	N (%)	OR (95% CI) ¹	N (%)	OR (95% CI)	N (%)	OR (95% CI)
R has been to Asia/Africa/South America:						
Yes	141 (15.3)	0.83 (0.61, 1.13)	103 (15.1)	0.79 (0.55, 1.14)*	36 (16.2)	1.03 (0.58, 1.84)
No	779 (84.7)		578 (84.9)		186 (83.8)	
Employment status:						
Yes	651 (72.4)	1.06 (0.82, 1.38)	487 (73.5)	1.05 (0.77, 1.44)	148 (57.0)	1.05 (0.67, 1.64)
No	248 (27.6)		176 (26.5)		73 (33.0)	
Marital status:						
Married	594 (66.3)	1.65 (1.30, 2.10)****	439 (66.4)	1.69 (1.27, 2.25)****	140 (63.9)	1.36 (0.88, 2.12)*
Other	302 (33.7)		222 (33.6)		79 (36.1)	
Type of home:						
Single house	675 (75.5)	1.39 (1.07, 1.80)*	514 (77.6)	1.55 (1.13, 2.12)**	138 (63.9)	0.81 (0.51, 1.29)
Other	219 (24.5)		148 (22.4)		78 (36.1)	
Location where R lives:						
city	274 (54.4)	0.96 (0.71, 1.31)	212 (57.5)	1.02 (0.70, 1.48)	53 (40.5)	0.80 (0.46, 1.38)
suburb	230 (45.6)		157 (42.5)		78 (59.5)	
Location where R lives:						
city	274 (58.3)	0.80 (0.58, 1.13)*	212 (69.7)	0.90 (0.58, 1.29)	53 (52.0)	0.59 (0.31, 1.14)*
small town	196 (41.7)		143 (40.3)		49 (48.0)	
Location where R lives:						
city	274 (57.9)	0.87 (0.62, 1.20)	212 (58.1)	0.88 (0.60, 1.30)	53 (58.2)	0.98 (0.52, 1.85)
rural area	199 (42.1)		153 (41.9)		38 (41.8)	
Location where R lives:						
suburb	230 (54.0)	0.85 (0.59, 1.19)	157 (52.3)	0.85 (0.56, 1.29)	78 (61.4)	0.74 (0.40, 1.38)
small town	196 (46.0)		143 (47.7)		49 (38.6)	
Location where R lives:						
suburb	230 (53.6)	0.91 (0.64, 1.27)	157 (50.6)	0.87 (0.58, 1.31)	79 (67.2)	1.22 (0.67, 2.24)
rural area	199 (46.4)		153 (49.4)		38 (32.8)	
Location where R lives:						
small town	196 (49.6)	1.07 (0.74, 1.55)	143 (48.3)	1.20 (0.66, 1.57)	49 (56.3)	1.64 (0.81, 3.31)*
rural area	199 (50.4)		153 (51.7)		38 (43.7)	
Years R has lived at current residence:						
≤ 10 years	672 (82)	1.09 (0.79, 1.49)	502 (83.0)	1.12 (0.76, 1.64)	156 (77.2)	0.99 (0.58, 1.69)
11 years +	148 (18)		103 (17.0)		46 (22.8)	
R's family is covered by health insurance:						
Yes	729 (87.0)	1.03 (0.71, 1.49)	540 (87.2)	0.92 (0.58, 1.46)	173 (85.2)	1.19 (0.64, 2.21)
No	109 (13.0)		79 (12.8)		30 (14.8)	
Respondent's age:						
18 to 44	539 (60.8)	1.11 (0.88, 1.42)	400 (60.9)	1.08 (0.81, 1.43)	128 (60.4)	1.28 (0.82, 2.00)
45 and older	347 (39.2)		257 (39.1)		84 (39.6)	
Respondent's race:						
White	772 (85.7)	1.01 (0.72, 1.41)	569 (85.6)	1.07 (0.73, 1.59)	191 (86.8)	0.81 (0.42, 1.57)
Other	129 (14.3)		96 (14.4)		29 (13.2)	

Table 10. (continued...)

Variable	U.S. (n=1750) ¹		U.S. excluding LD states (n=1247) ²		LD states (n=503) ²	
	N (%)	OR (95% CI) ¹	N (%)	OR (95% CI)	N (%)	OR (95% CI)
Respondent's level of education:						
	≤ high school	0.81 (0.64, 1.03)*	315 (46.7)	0.75 (0.56, 0.99)**	109 (49.5)	1.14 (0.75, 1.78)
> some college	482 (52.9)		360 (53.3)		111 (50.5)	
Household income:						
	≤ \$50,000	0.84 (0.64, 1.10)*	276 (53.2)	0.84 (0.61, 1.18)	76 (42.9)	0.74 (0.45, 1.21)
>\$50,001	341 (48.4)		243 (46.8)		101 (57.1)	
Respondent's sex:						
	Female	0.60 (0.48, 0.76)****	309 (45.3)	0.92 (0.58, 1.46)	96 (42.9)	1.19 (0.64, 2.21)
Male	515 (55.9)		373 (54.7)		128 (57.1)	

1. OR = crude odd ratio and 95% confidence interval; cases weighted by WT

2. Cases weighted by NEWT

*p<0.25, **p<0.05, ***p<0.01, ****p<0.001

Table 11. Logistic regression analysis predicting an index measure and several self-reported behaviors to prevent mosquito bites, United States, 1998.

Predictor variables	Sample	Individual Behaviors (OR, 95% CI) ¹						
		Used repellent to avoid bites	Used repellent on skin	Used repellent on clothes	Stayed indoors late afternoon and evenings	Wore long sleeves and long pants	Did anything else to avoid mosquitoes	Mosquito Bite Prevention Index Measure ²
R ¹ knows how someone gets encephalitis (Y/N)	I					0.66 (0.45, 0.97)*		
	II					0.64 (0.41, 0.99)*		
R believes encephalitis is a somewhat to extremely serious illness (Y/N)	I						0.53 (0.30, 0.94)*	
	II						0.15 (0.05, 0.46)***	
R is somewhat to very concerned to be bitten by mosquitoes (Y/N)	I	3.56 (2.40, 5.28)***	3.29 (2.24, 4.83)***	3.11 (2.13, 4.54)***	3.76 (2.42, 5.80)***	3.52 (2.39, 5.18)***	2.46 (1.61, 3.75)***	7.26 (4.31, 12.23)***
	II	3.10 (1.95, 4.94)***	2.93 (1.87, 4.60)***	2.85 (1.83, 4.45)***	3.38 (2.13, 5.36)***	3.14 (2.00, 4.93)***	2.58 (1.57, 4.24)***	6.38 (3.45, 11.79)***
	III	10.18 (4.03, 25.74)***	7.76 (3.19, 18.88)***	4.16 (1.84, 9.36)***	7.22 (2.66, 19.63)***	6.13 (2.50, 15.04)***		20.21 (6.14, 66.51)***
R believes using insect repellent is somewhat to very effective (Y/N)	III					0.20 (0.05, 0.82)*		
R believes staying indoors in late afternoon and evening is somewhat to very effective (Y/N)	I				2.80 (1.54, 5.07)***			
	II				2.40 (1.23, 4.67)**			
	III				10.95 (2.04, 58.87)**	3.67 (1.08, 12.41)*		
R believes wearing long pants/sleeves is somewhat to very effective (Y/N)	I		0.56 (0.34, 0.93)*		0.58 (0.35, 0.97)*			0.40 (0.21, 0.77)**
	II							0.42 (0.19, 0.95)**
	III	0.16 (0.05, 0.52)**	0.19 (0.06, 0.59)**		0.13 (0.04, 0.45)***			0.15 (0.04, 0.53)**
R believes insect repellent will make you sick (N/Y)	I	1.45 (1.01, 2.12)*	1.67 (1.15, 2.43)**		0.66 (0.44, 0.97)*	0.68 (0.47, 1.00)*		
	II	1.62 (1.04, 2.52)*	1.82 (1.17, 2.83)**		0.62 (0.39, 0.98)*			
	III						0.33 (0.11, 0.88)*	
R has dogs and/or cats as pets (Y/N)	I	1.42 (0.98, 2.06)*		1.59 (1.10, 2.33)*			1.58 (1.02, 2.44)*	
	II			1.68 (1.07, 2.64)*			1.94 (1.14, 3.28)**	
	III		2.84 (1.23, 6.55)**					

Table 11. (continued...)

Predictor variables	Sample ¹	Individual Behaviors (OR, 95% CI) ²						
		Used repellent to avoid bites	Used repellent on skin	Used repellent on clothes	Stayed indoors late afternoon and evenings	Wore long sleeves and long pants	Did anything else to avoid mosquitoes	Mosquito Bite Prevention Index Measure ³
R is married (Y/N)	I II	2.07 (1.37, 3.14)** 2.18 (1.34, 3.55)**	1.80 (1.19, 2.70)** 1.89 (1.17, 3.06)**	1.64 (1.00, 2.67)* 1.49 (1.03, 2.16)*	0.63 (0.42, 0.93)* 0.62 (0.39, 0.98)*	2.81 (1.75, 4.50)*** 3.08 (1.77, 5.35)***		
R lives in city/suburb (Y/N)	I II	1.51 (1.04, 2.19)* 1.66 (1.06, 2.59)*	1.61 (1.11, 2.33)** 1.64 (1.06, 2.54)*	1.90 (1.30, 2.77)*** 1.80 (1.16, 2.80)**	0.63 (0.42, 0.93)* 0.62 (0.39, 0.98)*		3.17 (1.20, 8.36)*	
R is 18-44 (Y/N)	I II	1.66 (1.06, 2.59)* 1.83 (1.25, 2.67)**	1.64 (1.06, 2.54)* 1.83 (1.25, 2.67)**	1.90 (1.30, 2.77)*** 1.80 (1.16, 2.80)**	0.63 (0.42, 0.93)* 0.62 (0.39, 0.98)*			
R is White (Y/N)	I II	1.66 (1.06, 2.59)* 1.83 (1.25, 2.67)**	1.64 (1.06, 2.54)* 1.83 (1.25, 2.67)**	1.90 (1.30, 2.77)*** 1.80 (1.16, 2.80)**	0.63 (0.42, 0.93)* 0.62 (0.39, 0.98)*			

I = OR = adjusted odds ratio, CI = confidence interval

2 I = U.S. sample, cases weighted by WT, II = U.S. sample excluding Connecticut, Delaware, New Jersey, New York, Pennsylvania, and Rhode Island, cases weighted by NEWT, III = (Over sampled states of Connecticut, Delaware, New Jersey, New York, Pennsylvania, and Rhode Island, cases weighted by NEWT

3 The index measure for the prevention of mosquito bites equals the sum of six behavioral variables (where respondent stated they had performed the action coded yes = 1 and no = 0) plus the sum of four frequency of action variables (where respondent stated they had performed the action "sometimes or often vs. occasionally," coded 1 and 0 respectively) that yielded an action score (range 0 to 10). The index measure was dichotomized and coded such that "action" equaled scores greater than or equal to 1 and no action equaled scores of 0

OR = respondent

*p<0.05, **p<0.01, ***p<0.001, non-significant data not shown