ABSTRACT

Title of dissertation: ASSESSING KNOWLEDGE, ATTITUDES, AND BEHAVIORS TOWARD WEST NILE VIRUS PREVENTION AMONG ADULTS ≥ 60 YEARS OLD IN MARYLAND: AN APPLICATION OF THE HEALTH BELIEF MODEL

Kimberly Carole Mitchell, Doctor of Philosophy, 2014

Dissertation directed by: Associate Professor Donna E. Howard
Department of Behavioral and Community Health

West Nile Virus (WNV) is a mosquito-borne virus and the leading cause of arboviral (arthropod-borne) disease in the U.S. While most WNV cases are asymptomatic, 20% of infected people develop WNV fever and < 1% develop severe neurologic disease. Individuals over 50 years old are at greatest risk of severe disease and death. Dramatic increases in WNV activity in 2012 underscored its unpredictable nature and highlighted concerns for adverse effects on older adults. It is important to understand factors that influence this population's engagement in WNV prevention.

This study analyzed data collected by the Maryland Department of Health and Mental Hygiene (DHMH) via cross-sectional survey to identify barriers to WNV prevention among adults ≥60 years of age. Subjects were recruited via stratified random sample of 1,700 households from counties with ≥ two WNV cases, enrolling 211 Maryland adults ≥ 60 years old. Six constructs of the Health Belief Model (HBM)--perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy--were examined to assess how they predicted attitudes and behaviors toward WNV prevention.

Univariate, bivariate and multivariate analyses examined the utility of the HBM for explaining WNV preventive behaviors in Maryland adults. Multivariate logistic regression models tested 36 hypotheses examining associations between HBM constructs and six outcomes: (1) avoiding the outdoors at dusk and dawn, (2) dressing in long-sleeved shirts and long pants when outdoors, (3) using insect repellent on exposed skin, (4) draining standing water from objects around one's property, (5) acceptance of a WNV vaccine, and (6) support for community mosquito control programs.

Findings showed high WNV knowledge and awareness but low perceptions of personal risk for WNV infection. Perceived susceptibility to WNV predicted use of insect repellent, draining of standing water from objects around the home, and acceptance of a WNV vaccine; perceived benefits were associated with draining standing water and support for mosquito control programs. Feelings of worry about WNV may inform future WNV interventions and risk communication to older adults. Findings have implications for theory-based research, which could probe applications of the HBM and other theories in understanding WNV attitudes and behaviors.

ASSESSING KNOWLEDGE, ATTITUDES, AND BEHAVIORS TOWARD WEST NILE VIRUS PREVENTION AMONG ADULTS ≥ 60 YEARS OLD IN MARYLAND: AN APPLICATION OF THE HEALTH BELIEF MODEL

by

Kimberly Carole Mitchell

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Advisory Committee
Associate Professor Donna E. Howard, Chair
Associate Professor Sharon M. Desmond
Assistant Professor Mary A. Garza
Associate Professor Kerry M. Green
Associate Professor Amy R. Sapkota

DEDICATION

I first dedicate this accomplishment to God, for it is only by His grace that I have prevailed.

This dissertation is also dedicated to my parents, whose unconditional love and support have seen me through this PhD journey and so many challenges before it. Because of you both I am a better person every day.

I must also share a special dedication to my mother, who unfailingly invested her time and energy in helping me through the dissertation process. Mom, you have quite literally been with me every step of the way. From lending your editing expertise on my tables and text, to offering a shoulder to lean on in my moments of exhaustion and frustration, you have been my teammate and biggest cheerleader. I share this victory with you, Mom. Thank you.

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CHAPTER 1: INTRODUCTION

1.1 Statement of Problem

West Nile Virus (WNV) is an arboviral (arthropod-borne) virus transmitted to humans by infected mosquitoes. It is currently the leading cause of domestically-acquired arboviral disease in the U.S., and is among the leading sources of severe neuroinvasive disease (Lindsey, Lehman, Staples, & Fischer, 2014). As such, WNV represents a significant public health problem nationwide. Due to the lack of an available human WNV vaccine, prevention of WNV disease relies largely on individual and community-level practice of personal protective behaviors (Lindsey et al., 2014). In the face of declining federal support for vector-borne disease surveillance and control efforts, a need exists to increase awareness of prevention measures and identify new strategies to reach out to individuals most at risk of severe WNV disease by promoting those behavioral measures.

This study examined the utility of the Health Belief Model at predicting knowledge, attitudes, and behaviors of Maryland adults at high risk of severe neurologic disease from WNV.

1.1.1 History

West Nile Virus is a mosquito-borne virus that was first isolated from a female patient in Uganda in 1937, and has historically been found in Africa, Asia, and the Middle East (Smithburn et al., 1940; Hayes et al., 2005). In the last decade, WNV has established a significant presence in the United States and is currently the leading cause of arboviral (arthropod-borne) disease in the U.S. (Murray et al., 2010). Since it was first documented in North America in 1999, significant human WNV epidemics were identified in 2002 and 2003 as the virus spread westward across the U.S. (O'Leary et al., 2004). Since then, WNV activity in humans, birds, mosquitoes, and veterinary species has been documented in every state except Hawaii, Alaska, and Oregon (CDC Q&A, 2012).

1.1.2 Epidemiology and Virology

West Nile virus is a Flavivirus, belonging to the same family of viruses as Yellow Fever, dengue hemorrhagic fever, and Japanese encephalitis (Hayes et al., 2005). It circulates through a primary transmission cycle between a mosquito vector and an avian reservoir, with horses, humans, and other vertebrates as incidental hosts (Murray et al., 2010). Although rare, a small number of human WNV cases transmitted via organ donation, blood transfusion, and intrauterine transmission have been reported (Hayes et al., 2005).

While most WNV cases are asymptomatic, approximately one in every 150 infected people develop severe neurologic disease and 20% of all infected people develop WNV fever (Hayes et al., 2005). In the U.S., case fatality rates for WNV range from 3-15% and are highest among individuals over 50 years of age (CDC COCA 2012). Individuals in this age group who become infected with WNV are at greatest risk of developing severe neuroinvasive disease, in the form of encephalitis, aseptic meningitis, or poliomyelitis (CDC COCA 2012). Thus, they are considered a high risk group for WNV.

Following the early WNV epidemics from 1999-2003, WNV activity throughout the US declined considerably. By the end of 2011, the national incidence of WNV neuroinvasive disease was 0.16 per 100,000 population, down from approximately 1.0

per 100,000 in 2003 (CDC COCA, 2012). However, in the summer of 2012, the disease made a dramatic resurgence in several states. Of the nearly 4,000 human WNV cases reported nationwide by the end of the first week of October, nearly 80% of those cases were reported from ten states: Texas, Louisiana, California, Illinois, Michigan, Mississippi, Nebraska, Colorado, Oklahoma, and South Dakota; and, over one-third of all cases documented nationwide were reported from Texas (CDC, 2012). In 2012, national health officials documented the largest WNV epidemic since the first epidemic in 2002, with 5,387 human WNV cases and 243 fatalities reported nationwide by December 11, 2012, the highest number of cases reported by that week since 2003 (CDC, 2012).

The increased WNV activity in 2012 illustrates the unpredictable and transient nature of the virus, and its often deleterious health effects on older adults are of grave public health concern (Bitto et al., 2005; Petersen et al. 2012).

1.1.3 West Nile Virus in Maryland

Although WNV activity in Maryland in 2012 did not increase in the same dramatic fashion as occurred in other states, the state did report its largest number of WNV human cases since the peak year of 2003, in which 73 human cases were reported statewide (Maryland Arbovirus Surveillance Results, 2012). By the end of 2012, 47 human WNV cases had been reported in Maryland, including four fatalities. Maryland health officials continue to monitor the disease in human and animal populations through rigorous surveillance efforts including adherence to standard case definitions and diagnostic procedures and thorough laboratory testing, but health officials have been hampered by reductions in federal funding for arboviral disease surveillance, which limits their capacity to maintain enhanced passive human surveillance and to sustain long-term mosquito surveillance.

The unexpected resurgence in West Nile disease activity has returned WNV to the forefront of public interest, prompting even greater scrutiny by state and local health officials, and bringing with it increased media attention and greater public concern about the risk the disease poses to Maryland residents (CDC Q&A, 2012). This heightened awareness highlights a need to better understand barriers to WNV prevention among Maryland residents, particularly among those at highest risk of severe disease.

1.2 West Nile Virus Prevention Measures

Public health professionals have identified specific health behaviors that aid in WNV prevention. These are referred to as personal protective behaviors (PPBs) and include using insect repellent (containing an EPA-registered ingredient such as N,N-diethyl-meta-toluamide or DEET) on exposed skin when outside, dressing in long-sleeved shirts and long pants when outdoors, avoiding outdoor activities during peak mosquito feeding hours (dusk and dawn), repairing damaged window screens, and draining or emptying areas of standing water (which can be potential mosquito breeding sites) around personal property (Zielinski-Gutierrez et al., 2003; CDC 2008). Although community level mosquito control programs that use larvicides and/or adulticides to kill juvenile and adult mosquitoes are also an important part of WNV prevention, individual WNV prevention behaviors remain vital to combating WNV infection, particularly among high-risk individuals.

Individuals' knowledge, perceptions, and behaviors with respect to WNV are often measured via survey. Knowledge of WNV is typically measured by asking respondents about the basics of WNV: how it is transmitted, which groups are at risk, and what prevention measures are available. Beliefs or perceptions are commonly measured by asking about perceived risk of getting infected with WNV, awareness of others who have gotten it, and opinions about recommended prevention steps. Behaviors are measured by asking about actions respondents took during a given time period to protect themselves and to avoid mosquito bites. PPBs are generally measured via a series of questionnaire items designed to capture the frequency with which people practice them (or the reasons why they don't) as well as their perceptions and opinions about the quality and effectiveness of such behaviors (Aquino et al., 2004; Loeb et al., 2005).

1.3 Theory Applied to WNV Prevention Behaviors

A small body of public health research has examined behavioral barriers to WNV prevention by evaluating PPB measures and some have incorporated a theoretical framework as the basis for their evaluation of WNV preventive behavior (Aquino et al., 2004; Bitto et al., 2005; Gujral et al., 2007). The theory that has been most commonly applied to the examination of health behaviors for WNV and other mosquito-borne disease prevention is the Health Belief Model (HBM). The HBM, a value-expectancy theory developed by federal public health officials in the 1950s, is a widely recognized theoretical model which posits that an individual will take steps to prevent, screen for, or control disease according to six constructs: perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy (Glanz et al., 2008). With respect to WNV, perceived susceptibility refers to the belief that one is vulnerable to getting WNV infection as well as knowledge of the impact of WNV disease, perceived severity indicates the extent to which a person believes WNV to be a serious illness that can cause morbidity and death, cues to action refer to specific triggers that prompt a person to engage in PPBs, and self-efficacy is the belief that one is capable of avoiding WNV infection through enactment of PPBs.

1.3.1 Existing Studies Applying HBM to WNV Prevention

In recent years, some researchers have applied the HBM to the study of behaviors concerning WNV and other mosquito-borne diseases (Aquino et al., 2004; Bitto et al., 2005; Herrington et al., 2003). These researchers have used the Health Belief Model as a theoretical framework to guide the development of survey instruments designed to capture WNV prevention behaviors.

Prior to the first national WNV outbreak in 1999, Herrington and colleagues conducted a nationally-based cross-sectional survey of 1,500 US adults plus an oversample of an additional 250 adults in six states to establish a baseline of their knowledge, attitudes, and behaviors toward WNV and other mosquito-borne diseases prior to that first outbreak. Their instrument measured respondents' knowledge of mosquitoes and arboviral encephalitis, perceptions of the severity of mosquito-borne disease, perceptions of their susceptibility to such illnesses, and beliefs about the effectiveness of recommended actions/behaviors to prevent mosquito-borne infections (Herrington et al., 2003). It was implemented via a computer-assisted telephone interview system (Herrington et al., 2003). Results revealed that being concerned about mosquito bites, perceiving insect repellents as effective and not harmful to health, and preferring to remain indoors during the late afternoon and early evening were all significant predictors of behaviors to prevent mosquito bites.

Similarly, in 2003, Aquino et al. conducted a survey of WNV PPBs among adult residents of British Columbia using the Health Belief Model as the theoretical framework. The study instrument measured the frequency of reported PPBs as well as selected constructs from the HBM, including perceived susceptibility, perceived severity, barriers and benefits to action, and cues to action. The authors found that the major barriers to practicing WNV PPBs were perception of DEET as an environmental and health hazard, time needed to drain standing water, and desire to engage in outdoor leisure activities during peak mosquito feeding times (Aquino et al., 2004).

Finally, Bitto and colleagues used the HBM to design and implement a tailored health education program among a sample of adults 50 years old and over in Monroe County, PA (Bitto et al.). This included administration of a cross-sectional survey instrument adapted from another state's health department. Survey items were framed around all six HBM constructs. Perceived susceptibility and perceived severity were examined collectively as perceived threat, perceived benefits referred to positive outcomes associated with taking steps to prevent WNV, and perceived barriers were identified as factors or obstacles that hinder actions to prevent WNV infection. Responses revealed that selected HBM constructs were highly relevant to this group, particularly perceived severity and perceived susceptibility to WNV infection (Bitto et al., 2005).

The above behavioral survey studies reveal the usefulness of incorporating the HBM into studies of WNV prevention behaviors. These and other studies of WNV prevention behavior are described in detail in the Literature Review.

1.4 Rationale for Study

1.4.1 Background and Pilot Study

Overall, little is known about the knowledge, attitudes, and behaviors of high-risk adults towards WNV prevention. Accordingly in 2012, the Maryland Department of Health and Mental Hygiene (DHMH) initiated a cross-sectional study with the aim of identifying barriers to WNV prevention among adults ≥ 60 years old.

While national recommendations for WNV prevention have denoted adults at least 50 years of age as at highest risk for WNV disease, for purposes of the DHMH study, the focus was on adults 60 years old and older in an effort to target those individuals who may encounter more barriers (physical, mental, and financial) when engaging in WNV prevention behaviors and to reach an accessible sample. People aged 60 years and over are more likely to have retired from work and to spend time at home or outdoors engaged in leisure-time activities that might bring them in contact with mosquitoes.

Staff at the Maryland Department of Health and Mental Hygiene, led by the Chief of Rabies and Vector-borne Diseases, who served as the primary investigator (KCM), coordinated the DHMH study including its conceptualization, design, and development from January to July 2012. The primary investigator of the DHMH Barriers study developed the original survey instrument, which included sections on Knowledge, Attitudes toward Prevention, and Demographic Factors, and worked with other DHMH epidemiologists to refine, pilot test, and administer it from August through December

2012. The implementation process included data collection and data management, along with training of interviewers and coding of questionnaire items.

The study, entitled: "*Assessment of Barriers to West Nile Virus Prevention among Adults at Least 60 Years Old in Maryland*", (the Maryland WNV Barriers Study) used a proportionate random sample of 1700 households stratified by zip code from counties with two or more previous WNV cases. From this sampling frame, 211 individuals meeting eligibility criteria were enrolled. Eligibility criteria included age 60 years of age or older, English-speaking, and living independently (not in a long term care facility, nursing home, or other institution). Telephone interviews were conducted with all enrollees by trained interviewers. The survey instrument incorporated elements of existing surveys of WNV prevention behavior and used the HBM as a theoretical framework. It asked questions about the respondents' knowledge and awareness of WNV, use of PPBs, and perceptions of the effectiveness of PPBs, insect repellents, and other products (e.g. WNV vaccine). The purpose of the study was to identify barriers to WNV prevention among Maryland residents 60 years old and older given their elevated risk for severe WNV disease. Survey administration concluded in December 2012.

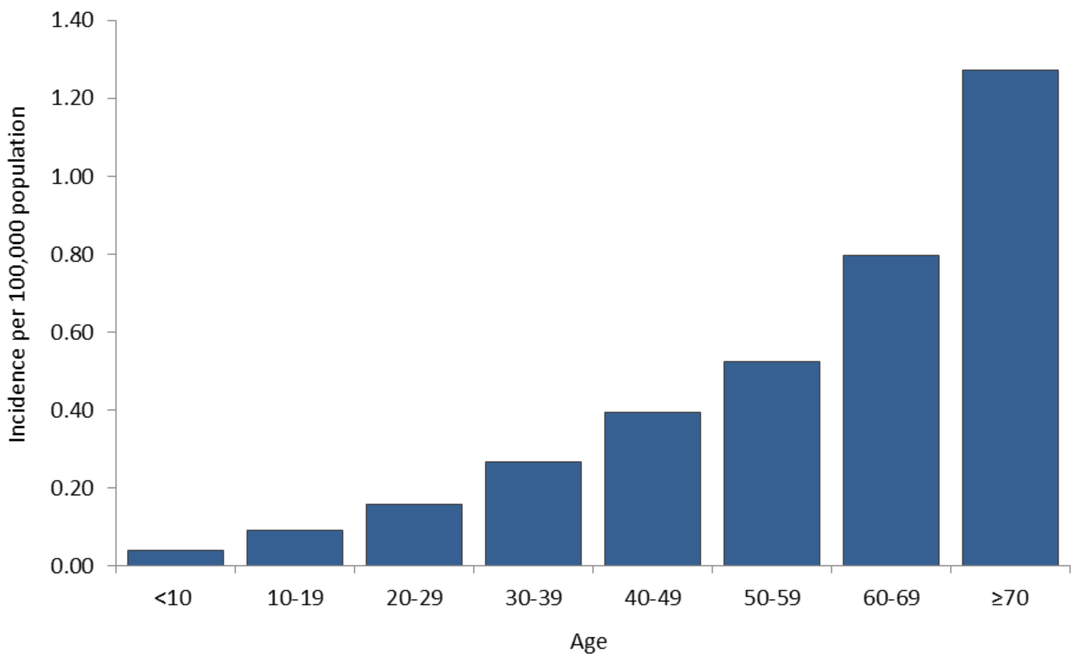
1.4.2 Purpose and Rationale

The purpose of this dissertation study was to evaluate the utility of the Health Belief Model for predicting WNV knowledge, attitudes, and practices among adults 60 years of age and over in Maryland, using a proportionate random sample of adults from the Maryland WNV Barriers Study. This study involved primary analysis of a subset of data from the larger DHMH WNV Barriers study, and examined six HBM constructs: perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy to determine their individual effectiveness at predicting participants' perceptions and behavior. Although the target sample size was 256 participants, 211 were ultimately enrolled, which was believed to yield sufficient statistical power for testing of study hypotheses.

The rationale for undertaking this dissertation study was three-fold. First, WNV made a dramatic resurgence in 2012, and it has been described as "the adolescent that never grows up," due to its sporadic occurrence and dramatically unpredictable nature; moreover, such fluctuations in WNV incidence are expected to continue in the future (Petersen et al., 2012). Because WNV activity is shaped by a multitude of ecologic factors, including climate, vector biology, host migration, and human behavior patterns, it is impossible to fully predict the timing or intensity of future occurrences (Petersen et al., 2012). Given this uncertainty, and given the absence of an available human WNV vaccine, personal prevention measures are even more important to prevent human WNV disease during these epidemics. As there is limited availability of theory-based studies examining such WNV prevention behavior in the literature, a study demonstrating the utility of the Health Belief Model to explain or predict WNV prevention behavior among high-risk Maryland residents could be of considerable value.

Second, adults 60 years of age and over have been identified as among those at highest risk for developing severe WNV disease in the form of encephalitis, aseptic meningitis, meningoencephalitis, or WNV poliomyelitis, a form of acute flaccid paralysis (CDC COCA, 2012). Given that this group is most vulnerable to severe illness and death from WNV, and that there is a rapidly growing senior population in the US and in Maryland, a pressing need exists to understand the beliefs and motivations that hamper or encourage this population to engage in WNV preventive behaviors. Figure 1 below provides a breakdown of the average annual incidence of WNV neuroinvasive disease by age group. It clearly illustrates that the majority of WNV cases involving severe neurologic illness occur among adults ≥ 50 years of age (CDC).

Third, previously developed theory-based instruments for measuring WNV prevention behaviors have not been validated for adults in this high-risk group in Maryland. A dissertation by Yerby (2007) remains the only validation study of WNV beliefs, attitudes, and behaviors, and it studied a sample of women aged 19 and older living in West Alabama (Yerby, 2007). It would be useful to conduct an assessment of a theoretical model for predicting WNV protective behaviors in adults aged 60 years old and older in Maryland. Use of a theory-based instrument is relevant because it provides a conceptual or a guiding framework for understanding, explaining and/or predicting health protective behaviors. Given the ambiguities and challenges associated with determining relationships between HBM constructs, particularly for cross-sectional designs, this study did not attempt to capture such mediating relationships (Glanz, 2008; Carpenter, 2010). This dissertation may further expand the field of vector-borne disease research by providing additional support for a widely-recognized theoretical model to effectively predict WNV prevention behaviors in populations at risk. Findings from this research can be used in the development of targeted interventions and media campaigns for prevention of WNV exposure among high risk Maryland residents.



Source: ArboNET, Arboviral Diseases Branch, Centers for Disease Control and Prevention

Figure 1. Average annual incidence of West Nile Virus neuroinvasive disease reported to CDC by age group, 1999-2013

1.5 Research Question and Hypotheses

Research Question: Is the Health Belief Model a useful theoretical framework for predicting perceptions and behavior toward West Nile virus prevention among Maryland adults 60 years of age and older?

The following 36 hypotheses were used to test the six HBM constructs against each of the following six outcomes: (1) avoidance of the outdoors at prime mosquito feeding hours of dusk and dawn, (2) dressing in long shirts and pants when outdoors, (3) use of insect repellent in the previous 90 days, (4) draining standing water from objects around the property, (5) willingness to accept a WNV vaccine if one were available, and (6) support for community mosquito control programs.

Hypotheses 1-6: Perceived susceptibility to WNV disease

1. Individuals with high perceived susceptibility to WNV infection are more likely to avoid going outdoors during mosquito feeding hours of dusk and dawn than those with low perceived susceptibility.

2. Individuals with high perceived susceptibility to WNV infection are more likely to dress in long-sleeved shirts and long pants to avoid mosquito bites than those with low perceived susceptibility.
3. Individuals with high perceived susceptibility to WNV infection are more likely to have used insect repellent in the last 90 days than those with low perceived susceptibility.
4. Individuals with high perceived susceptibility to WNV infection are more likely to drain standing water from objects around their property than those with low perceived susceptibility.
5. Individuals with high perceived susceptibility to WNV infection are more likely to accept a human WNV vaccine if one were available than those with low perceived susceptibility.
6. Individuals with high perceived susceptibility to WNV infection are more likely to support mosquito control programs in their community than those with low perceived susceptibility.

Hypotheses 7-12: Perceived severity of WNV disease

7. Individuals who perceive WNV as causing serious illness are more likely to avoid going outdoors during mosquito feeding hours of dusk and dawn.
8. Individuals who perceive WNV as causing serious illness are more likely to dress in long-sleeved shirts and long pants to avoid mosquito bites.
9. Individuals who perceive WNV as causing serious illness are more likely to have used insect repellent in the last 90 days.
10. Individuals who perceive WNV as causing serious illness are more likely to drain standing water from objects around their property that collect water.
11. Individuals who perceive WNV as causing serious illness are more likely to accept a human WNV vaccine if one were available.
12. Individuals who perceive WNV as causing serious illness are more likely to support mosquito control programs in their community.

Hypotheses 13-18: Perceived benefits of practicing WNV protective behaviors

13. Individuals who perceive benefits in practicing WNV protective behaviors are more likely to avoid going outdoors during mosquito feeding hours of dusk and dawn.
14. Individuals who perceive benefits in practicing WNV protective behaviors are more likely to dress in long-sleeved shirts and long pants to avoid mosquito bites.
15. Individuals who perceive benefits in practicing WNV protective behaviors are more likely to have used insect repellent in the last 90 days.
16. Individuals who perceive benefits in practicing WNV protective behaviors are more likely to drain standing water from objects around their property that collect water.
17. Individuals who perceive benefits in practicing WNV protective behaviors are more likely to accept a human WNV vaccine if one were available.
18. Individuals who perceive benefits in practicing WNV protective behaviors are more likely to support mosquito control programs in their community.

Hypotheses 19-24: Perceived barriers to practicing WNV protective behaviors

19. Individuals with high perceived barriers to practicing WNV protective behaviors are less likely to avoid going outdoors during mosquito feeding hours of dusk and dawn than those with low perceived barriers.
20. Individuals with high perceived barriers to practicing WNV protective behaviors are less likely to dress in long-sleeved shirts and long pants to avoid mosquito bites than those with low perceived barriers.
21. Individuals with high perceived barriers to practicing WNV protective behaviors are less likely to have used insect repellent in the last 90 days than those with low perceived barriers.
22. Individuals with high perceived barriers to practicing WNV protective behaviors are less likely to drain standing water from objects around their property than those with low perceived barriers.
23. Individuals with high perceived barriers to practicing WNV protective behaviors are less likely to accept a human WNV vaccine if one were available than those with low perceived barriers.
24. Individuals with high perceived barriers to practicing WNV protective behaviors are less likely to support mosquito control programs in their community than those with low perceived barriers.

Hypotheses 25-30: Cues to action for preventing WNV infection

25. Individuals who receive cues to action for preventing WNV infection are more likely to avoid going outdoors during mosquito feeding hours of dusk and dawn than those who do not receive cues to action.
26. Individuals who receive cues to action for preventing WNV infection are more likely to dress in long-sleeved shirts and long pants than those who do not receive cues to action.
27. Individuals who receive cues to action for preventing WNV infection are more likely to have used insect repellent in the last 90 days than those who do not receive cues to action.
28. Individuals who receive cues to action for preventing WNV infection are more likely to drain standing water from objects around their property than those who do not receive cues to action.
29. Individuals who receive cues to action for preventing WNV infection are more likely to accept a human WNV vaccine if one were available than those who do not receive cues to action.
30. Individuals who receive cues to action for preventing WNV infection are more likely to support mosquito control programs in their community than those who do not receive cues to action.

Hypotheses 31-36: Self-efficacy for preventing WNV infection

31. Individuals with high self-efficacy for preventing WNV infection are more likely to avoid going outdoors during mosquito feeding hours of dusk and dawn than those with low self-efficacy.
32. Individuals with high self-efficacy for preventing WNV infection are more likely to dress in long-sleeved shirts and long pants to avoid mosquito bites than those with low self-efficacy.
33. Individuals with high self-efficacy for preventing WNV infection are more likely to have used insect repellent in the last 90 days than those with low self-efficacy.
34. Individuals with high self-efficacy for preventing WNV infection are more likely to drain standing water from objects around their property than those with low self-efficacy.
35. Individuals with high self-efficacy for preventing WNV infection are more likely to accept a human WNV vaccine if one were available than those with low self-efficacy.
36. Individuals with high self-efficacy for preventing WNV infection\are more likely to support mosquito control programs in their community than those with low self-efficacy.

1.6 Summary

Chapter 1 provided an overview of West Nile virus, including its origins, pathogenesis, and epidemiology in the United States and Maryland. It outlined the purpose and rationale for this study, which examined the Health Belief Model as a theoretical framework for explaining WNV prevention behaviors in a sample of high-risk adults ages 60 and over in Maryland. By conducting a primary analysis of data collected during a cross-sectional study by the Maryland Department of Health and Mental Hygiene, this study examined the application of six constructs of the HBM for predicting WNV prevention behavior among adults 60 years of age and older. This study has implications for the development of future behavioral interventions to reduce the WNV disease burden in this population.

1.7 Definition of Terms

Acute Flaccid Paralysis: Any condition caused by the weakening or loss of muscle tone

Arbovirus: Arthropod-borne virus; any of a group of viruses transmitted by mosquitoes, ticks, and other arthropods

Encephalitis: An inflammation of the brain

Flavivirus: Any virus belonging to the family Flaviridae, which includes Yellow Fever, Dengue hemorrhagic fever, and St. Louis encephalitis

Meningitis: Inflammation of the membranes surrounding the brain and spinal cord

Meningoencephalitis: Inflammation of both the brain and the membranes surrounding it

Neuroinvasive Disease: Any illness affecting the central nervous system

Non-neuroinvasive Disease: Illness that causes physical symptoms but does not involve the nervous system

Poliomyelitis: Inflammation of the spinal cord; typically characterized by paralysis

Vector: an intermediate organism in indirect transmission that carries the agent from a reservoir (source) to a susceptible host

West Nile Virus: A virus belonging to the same group that includes Japanese encephalitis and St. Louis encephalitis and causes clinical illness affecting the nervous system

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction and Purpose

The purpose of this study was to examine the utility of the Health Belief Model for predicting WNV knowledge, attitudes, and behaviors among adults 60 years of age and older in Maryland. This review of the literature includes an overview of West Nile virus, including its history, epidemiology, prevention, surveillance, and public health impact in the United States and Maryland. This is followed by a description of the history, constructs, and applications of the Health Belief Model (HBM). It examines key themes in the existing literature on the HBM as it applies to WNV prevention behavior. The primary objective of the review is to provide a better understanding of the application of constructs from the Health Belief Model to West Nile virus prevention behaviors. Examples are offered of the salient, but limited, literature on WNV protective behaviors, with emphasis on those studies that used the HBM as a theoretical framework. Emphasis is placed on the anticipated contribution that this study will make to the fields of both infectious disease epidemiology and health promotion.

Methods for Literature Search

The following databases were searched during this review: Academic Search Premier, Medline, PubMed, CINAHL, ERIC, PsychInfo, and Social Science Abstracts. Key search terms included combinations of the following: West Nile virus, mosquito, vector-borne disease, knowledge, perceptions, beliefs, attitudes, behavior, and Health Belief Model. Inclusion criteria were: (1) English language, (2) research based in North America (US or Canada), and (3) measurement of perceptions, attitudes, and/or behaviors toward West Nile Virus and/or other mosquito-borne diseases. Both quantitative and qualitative studies were included, and a variety of study designs, including cross-sectional surveys, focus groups, and randomized controlled trials. Of the 20 articles identified that examined knowledge, attitudes, and/or practices related to WNV prevention, only seven applied a theoretical model or framework, which in each instance was the HBM. The extant literature was reviewed to compare approaches to examination of WNV attitudes and behavior and to examine overall assessment of WNV knowledge, perceptions, and protective behavior.

2.2 West Nile Virus Overview

2.2.1 History and Geographic Distribution

West Nile virus (WNV) is a mosquito-borne virus that was first isolated from a febrile female patient in the West Nile province of Uganda in 1937 (Murray et al., 2011). As such, it is one of the earliest recognized arboviruses (arthropod-borne viruses) and belongs to the genus Flavivirus of the family Flaviridae (Murray et al., 2011). The virus is maintained in a transmission cycle between mosquito vectors and bird reservoir hosts with humans, horses, and other mammals as incidental (dead-end) hosts. Originally documented in the Old World throughout Africa and Eurasia (including India, the Middle East, and various regions in Europe, Asia, and Russia) the virus rapidly spread to the Americas, eventually emerging in the Western Hemisphere (Artsob et al., 2009). Following its initial emergence in North America in 1999, WNV spread rapidly westward from its origin in New York throughout the other East Coast states including Maryland and subsequently across the U.S. as well as northward into Canada (Artsob et al., 2009).

2.2.2 Epidemiology and Emergence in the U.S. and Maryland

2.2.2.1 WNV in United States

WNV was first introduced in the Western hemisphere in 1999 and in 2002 caused the largest epidemic of human neurological disease in the U.S., with over 4100 human cases (both neuroinvasive and non-neuroinvasive disease) reported in 39 states and the District of Columbia (Zielinski-Gutierriez, 2003). Federal health officials documented the peak incidence of WNV neuroinvasive disease in the years 2002-2003, at 1.02 per 100,000 U.S. population (DeBiasi, 2011). Following several subsequent years of more moderate but ongoing WNV activity nationwide, the Centers for Disease Control and Prevention (CDC) announced in summer 2012 that increases in WNV activity have been reported in some parts of the country. A media advisory in fall 2012 reported that selected states, including Texas, Oklahoma, and Mississippi, had been experiencing significantly greater human WNV activity that year.

2.2.2.2 WNV in Maryland

West Nile virus is one of three arboviruses of public health significance in Maryland, along with LaCrosse encephalitis virus (LAC) and St. Louis encephalitis virus (SLE). Since the introduction of West Nile virus (WNV) into the U.S. in 1999, Maryland's experience with WNV and other arboviruses has been similar to that of many other regions of the country. In 2001, Maryland reported its first human WNV activity, with six human cases including three fatalities. During the peak year of 2003, 73 human cases with eight fatalities were reported. Human arboviral activity has declined in subsequent years, yet continues to pose a threat to Maryland residents. In 2010, 23 human cases were reported, along with eight WNV-positive mosquito pools, one WNV equine case and two human cases of LaCrosse encephalitis. In 2011, 19 human WNV cases, including one fatality, were identified in six Maryland jurisdictions, in addition to arboviral activity in mosquitoes, birds, and horses. A single human case of St. Louis encephalitis was identified that year as well. A dramatic upsurge in WNV activity was seen in Maryland and throughout the U.S. in 2012. By the close of the 2012 arboviral surveillance season on October 31, 46 human WNV cases and four fatalities had been reported in the state. Although Maryland was among a handful of states that experienced elevated WNV activity in 2012, other states in the south, west, and Central Plains accounted for the majority of WNV activity, including Texas, Louisiana, California, and Mississippi, which were among the 13 states that accounted for 80% of all WNV cases that year (CDC). Each year in Maryland, the appearance of the first human WNV case serves as a pivotal reminder that the disease remains a public health threat and that Maryland residents must continue to take precautions. State health officials continue to monitor these arboviral diseases and to assess their impact on Maryland communities and to determine barriers for reducing risk.

Maryland is a small, densely-populated state in the mid-Atlantic region of the U.S., and its varied population, topography, and climate present numerous public health opportunities and challenges. The state's population, as reported by the 2010 U.S. census, is 5.8 million, and this represents a 9% increase since the 2000 U.S. census. The majority of Maryland's population is concentrated in the cities and suburbs surrounding Maryland's most populous city, Baltimore, and the nation's capital, Washington, District of Columbia. The eastern, southern, and western portions of the state are more rural, ranging from the Atlantic Coastal Plain in the east where Maryland's easternmost county, Worcester, meets the Atlantic Ocean, to the mountainous region in Maryland's westernmost counties: Garrett, Allegany, Washington and Frederick. Surveillance for WNV and other arboviruses is coordinated through a partnership between state officials in the departments of Health and Mental Hygiene, Agriculture, and Natural Resources in collaboration with local health departments and the Department of Defense.

2.2.3 West Nile Virus: Disease Classification

Belonging to the Japanese encephalitis virus serocomplex along with LAC and SLE, WNV can cause neuroinvasive disease (disease involving the brain and central nervous system) in humans, in the form of encephalitis (swelling of the brain), meningitis (swelling of the membranes surrounding the brain and spinal cord), meningoencephalitis, or acute flaccid paralysis (weakness or paralysis and reduced muscle tone). Approximately 20% of infected individuals develop a milder WNV Fever, a non-neuroinvasive form of disease characterized by flu-like symptoms including fever, headache, body aches, tiredness, and possible skin rash. The epidemiology of WNV incidence in human populations is seasonal in accordance with the life cycle of the mosquito vectors, usually from early June through late October. Although the most common mode of transmission is via the bite of an infected mosquito, rare instances of transmission through organ donation, blood transfusion, and intrauterine transmission have been previously documented (Hayes et al., 2005).

2.2.4 Transmission

West Nile Virus is primarily transmitted through the bite of an infected mosquito. Mosquitoes become infected with WNV when they feed on infected birds, and can then spread the virus to humans and other animals (CDC, 2008). Most infected birds survive, but some, particularly American Crows and Blue jays, will sicken and die from the infection. Horses and humans are considered dead-end hosts of the virus, because they do not develop a high level of virus in their blood, and therefore cannot pass the virus on to another biting mosquito (CDC, 2008).

Several mosquito vectors have been implicated in the spread of WNV both nationwide and in Maryland. As described in the 2013 CDC Guidelines for Management of Arboviruses, WNV has been detected in 65 different mosquito species nationwide (CDC 2013). Mosquitoes belonging to the *Culex* species have been found to be the primary vector of WNV in the U.S., depending on the geographic region. In the northeast, the *Culex pipiens*, *Culex restuans*, and *Culex salinarius* species are the most common WNV vectors (Molaei, 2006).

Culex mosquitoes typically feed (take blood meals) during the hours of dusk and dawn (Molaei, 2006), and serve as the basis for recommendations that people avoid going outdoors during those times, as they are considered the prime mosquito feeding hours.

2.2.5 Clinical Presentation

Most WNV-infected individuals remain asymptomatic (~80%), while another 20% typically develop WNV Fever (WNF), a milder, self-limiting illness whose hallmarks include fever, headache, muscle aches, and gastrointestinal upset (DeBiasi, 2011). While WNF cases originally appeared to pose minimal disease burden to infected individuals, recent research has revealed that a small but growing number of such cases are resulting in death, particularly among the elderly (Sejvar, 2011). Although only a small percentage of infected individuals develop neuroinvasive disease (<1%), the effects can be severe. While most such West Nile neuroinvasive disease (WNND) cases present with encephalitis or aseptic meningitis, approximately 5-15% present with acute flaccid paralysis, a syndrome resembling poliomyelitis with symptoms that range from single extremity weakness to paralysis or quadriplegia (Murray et al., 2011). Serological surveys have been conducted to determine the prevalence of WNV antibodies among human populations in areas of documented WNV transmission in the US (Artsob et al., 2011). Previous serologic surveys have noted that for every case of WNV neuroinvasive disease, there are approximately 140 WNV infections, suggesting that the impact of WNV outbreaks may extend beyond those cases detected by surveillance systems (DeBiasi, 2011). The CDC collaborated with state health officials to establish a passive surveillance system, ArboNet, through which human WNV cases are reported nationally (Sejvar et al., 2011). Through this system, state health departments routinely monitor arboviral activity in their respective states, reporting cases according to established public health guidelines that classify neuroinvasive and nonneuroinvasive disease according to specific clinical and laboratory criteria which must be met in order to classify a Confirmed or Probable WNV or other arboviral case (CDC NNDSS, 2011).

2.2.6 Populations at Risk for WNV

Any person living in an area where mosquitoes are active is at risk for WNV infection. Individuals who spend significant amounts of time outdoors, where they are more likely to come into contact with mosquitoes are at higher risk of infection than those who largely remain indoors. However, age remains by far the most critical risk factor for developing severe WNV disease. According to the CDC, persons 50 years of age and older have been identified as a high-risk group for WNV disease, as they are more vulnerable to diseases of the central nervous system, resulting in encephalitis, aseptic meningitis, or meningoencephalitis (CDC COCA, 2012). A total of 123 non-fatal human WNV cases were reported in the U.S. from 1999-2001, of which 60% were over 60 years old; while the same age group accounted for 75% of the fatal cases (Elliott et al., 2008). Similarly, in the U.S. in 2004, people aged 50 and older accounted for over 60 percent of severe West Nile cases and 95 percent of deaths due to WNV (CDC COCA, 2012).

Earlier studies have suggested that despite its high fatality rate, particularly among elderly individuals, that those who survive WNV disease tend to have favorable outcomes (Berner et al., 2003), but more recent research has suggested otherwise (Lindsey et al., 2012).

Since human arboviral activity was first detected in Maryland in 2001, there have been 21 WNV fatalities and all were among persons over 50 years of age (range 54-93 years; mean: 72.5 years) (Maryland Arbovirus Surveillance Summary Report, 2011). The impact of WNV infection in older adults has been well-established (Berner et al., 2002; Sejvar et al., 2011). Prior research has noted the value of assessing WNV risks, perceptions, and behavior in elderly populations, but only a few studies have focused exclusively on this group. LaBeaud et al. compared pediatric and adult behaviors relevant to WNV exposure, but looked broadly at all adults 18 years of age and older rather than examining risk and behavior in the over 50 population (LaBeaud et al., 2007). A need exists to better understand the behavioral risks common to this high-risk age group and to identify impediments to prevention so that tailored interventions can be developed to promote increased prevention measures and reduce WNV disease and mortality in this population.

While national recommendations have generally targeted adults at least 50 years of age, for purposes of this study, the focus was on adults 60 years old and older in an effort to target those individuals who may encounter more barriers (physical, mental, financial, or otherwise) when engaging in WNV prevention behaviors. Specifically, people aged 60 years and over are more likely to have retired from work and to spend time at home or outdoors engaged in leisure-time activities that might bring them in contact with mosquitoes. People in this age group may also be more subject to financial limitations of a fixed income (social security) that could limit their ability to support local mosquito control programs or to purchase tools that may aid in mosquito bite prevention.

2.2.7 Prevention Behaviors

In light of the ongoing public health threat posed by WNV throughout the country, effort has been made to identify WNV behavioral risk factors and effective prevention measures. In the absence of an available human WNV vaccine and given the sometimes undetectable nature of WNV infection, personal behaviors have been identified as important for preventing WNV disease. Key prevention measures are recommended to lower the risk of WNV infection. These key individual personal protective behaviors are commonly referred to as the 4 D's: DEET (wearing insect repellent containing DEET), Dress (wearing long sleeves and long pants when outdoors), Drain (draining objects that may collect water in which mosquitoes lay eggs), and Dusk to dawn (avoiding the outdoors during prime mosquito feeding hours of dusk and dawn) (Gujral et al., 2007). Other prevention measures include source reduction measures such as eliminating routes of indoor exposure by repairing damaged window and door screens and cleaning gutters where water may collect. Prior research has examined the frequency with which individuals perform the above preventive behaviors and tested the association of those behaviors with a reduction in WNV infection among various populations (Loeb et al., 2005; Gujral et al., 2007). Findings from these studies suggest that engaging in these preventive steps can significantly reduce the risk of WNV infection. In addition, community prevention efforts in the form of mosquito control programs further supplement individual protective behaviors to reduce WNV activity. These community prevention methods generally involve widespread mosquito control programs that reduce the number of mosquitoes and seek to eliminate mosquito habitats. Such methods include adulticiding (applying pesticides to kill adult mosquitoes) and larviciding (products used to kill immature mosquitoes before they reach adulthood) (CDC, 2008).

2.3 Health Belief Model

2.3.1 Definition and Origins of Model

The Health Belief Model (HBM) was created for the purpose of explaining an individual's engagement in a particular health behavior and provides a theoretical framework for describing individual actions according to perceptions of the risks and benefits associated with the target behavior. Originally developed in the 1950s by US Public Health Service officials to explain people's lack of participation in free tuberculosis screening programs and other preventive health services, the HBM has since evolved in response to the ever-changing needs of the public health community (Hochbaum, 1958; Rosenstock 1960, 1974). It has been widely applied within three domains of health behavior: 1) preventive health behaviors, including health protective and risk reducing behaviors; 2) sick role behaviors, including compliance; and, 3) clinical or medical care seeking behaviors (Janz & Becker, 1984). Although the model has been modified and expanded over the years since its inception, to adapt to various public health concerns, it traces its origin to two psychosocial learning theories: Stimulus-Response Theory and Cognitive Theory (Champion & Skinner, 2008). Proponents of the former believed an individual's behavior was driven by events or reinforcements that accrue after the behavior has been enacted, while proponents of the latter maintained that learning was a function of the subjective value of an outcome and the probability or expectation that certain actions would lead to that outcome (Champion and Skinner, 2008). Thus, the HBM is considered a value-expectancy theory. As such, the model has been formulated to depict the value that an individual assigns to an outcome associated with his/her expectation that performing a particular behavior will result in that outcome. Specifically, the likelihood of a person engaging in a preventive behavior is a function of a subjective process of weighing the costs and benefits of taking the action. Those costs and benefits are direct determinants of an individual's actions, which prompt adoption of a behavior (Reid et al., 2011). In short, the model posits that a person will take steps to avoid illness and reduce his/her risk of disease with the expectation of a positive health outcome (Janz & Becker, 1984).

2.3.2 Health Belief Model Structure

The original Health Belief Model consists of four core constructs: perceived susceptibility (whether a person considers him/herself to be at risk for the disease), perceived severity (how serious a person believes the disease to be), perceived benefits (one's belief in the efficacy of the recommended action to reduce the risk or seriousness of an adverse outcome), and perceived barriers (one's opinion of the tangible and psychological costs of the recommended action). Perceived susceptibility and perceived severity together form perceived threat, or the motivation to take action (Murray-Johnson et al., 2006). This combined mechanism is believed to provide a person with the force or energy to act on a behavior (Janz and Becker, 1984). Barriers refer to a person's assessment or appraisal of potential adverse consequences that may occur as a result of taking a health action (Mattson et al., 1999). As described by Mattson et al., perceived barriers can be physical, psychological, financial, or emotional (Mattson et al., 1999). Benefits refer to the extent to which a person considers certain health behaviors to be effective or beneficial at reducing risk or impact of the disease (Wong et al., 2005). Several studies have suggested that among all the HBM constructs, perceived barriers are the most powerful predictor of health behavior (Mahoney et al., 1995; Atkinson et al., 2009; Chin et al., 2012). Similar to how severity and susceptibility combine to form perceived threat, perceived benefits and perceived barriers are collectively regarded as composing a person's outcome expectancy, or likelihood of taking action (Michel et al., 2011; Murray-Johnson et al., 2006). When combined, these two constructs act in an additive fashion, with barriers subtracted from benefits to yield a net behavioral effect, making it possible to estimate a person's likelihood of engaging in a specific action (Murray-Johnson, 2006; Carpenter, 2010).

Cues to action were also included in the original HBM for the purpose of activating behavior. The cues serve as triggers or stimuli that prompt persons to engage in a specific health behavior. They can be internal (e.g. symptoms of illness) or external (e.g. disease in family members or friends or media health outreach) to the individual and are designed to create awareness of the health threat as well as to stimulate a readiness to act against it (Mattson et al., 1999; Atkinson et al., 2009). Recent articles in the literature have noted that cues to action remain the least researched and least developed of all the HBM constructs and as such are often addressed in only a cursory fashion (Carpenter, 2010; Mattson et al., 1999). As a result, such cues are rarely addressed in intervention research that examines the application of the HBM to specific health behaviors (Mattson et al., 1999; Carpenter, 2010). Despite the insufficient research on cues to action, they have been demonstrated to serve as valuable motivators to action for such behaviors as Severe Acute Respiratory Syndrome (SARS) prevention efforts, diabetes foot exam practice, and use of birth control (Chin et al., 2012; Wong et al., 2005; Wang et al., 2006).

Self-efficacy (confidence in one's ability to perform a given behavior) was added to the HBM in 1988 by Rosenstock, Strecher, and Becker to address the need for individuals to feel competent to surmount adverse health habits such as smoking and overeating (Rosenstock et al., 1988). The authors were careful to make a distinction between efficacy expectations (the belief that one can successfully execute the necessary behavior to yield an outcome) and outcome expectations (the conviction that a specific behavior will likely lead to a particular outcome) so as to eliminate any confusion over such different perceptions and clarify that the former involves a judgment of one's own abilities (Rosenstock et al., 1988).

The self-efficacy construct arose from Bandura's Self-Efficacy Theory, which was introduced in 1977 and defined a person's perceived efficacy as a situational awareness of his/her own abilities to act in certain situations (van der Bijl, 2001). The construct has been described as arising from four key information sources: (1) personal accomplishments, (2) vicarious experiences, (3) verbal persuasion, and (4) physiological information (van der Bijl, 2001). As such, it reflects a person's belief in his/her ability to surmount a specific task or situation, by making judgments about their capacity to learn a new behavior and/or curtail a damaging one (AbuSabha et al., 1997). The construct of self-efficacy typically applies to habitual or repeated behaviors, such as smoking, physical activity, and dietary behaviors (Brewer and Rimer, 2008). It has been shown to have high specificity and effectiveness at predicting smoking cessation, weight control, and exercise (AbuSabha et al., 1997).

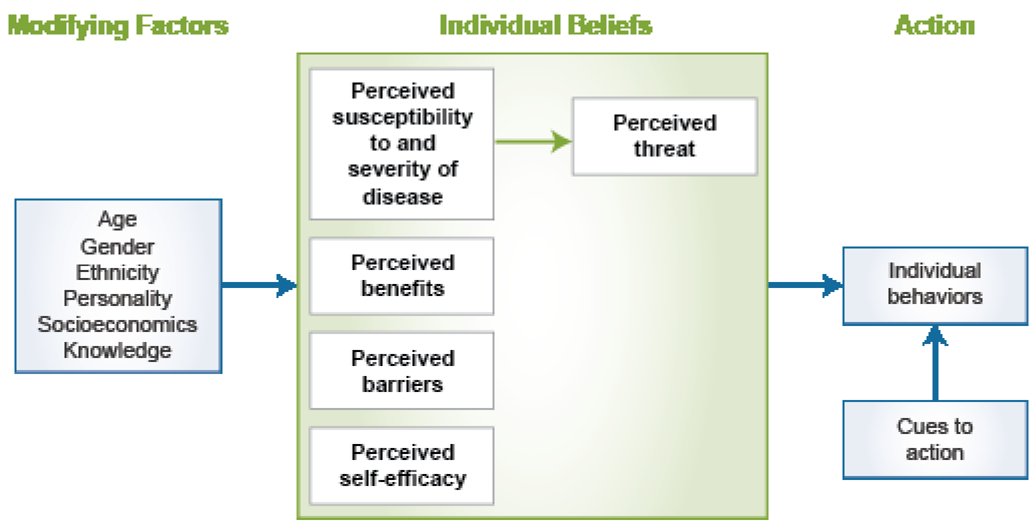
Testing of the self-efficacy construct can be complex and requires measurement according to the three central dimensions of magnitude, strength, and generality (AbuSabha et al., 1997, van der Bijl 2001). Self-efficacy has been demonstrated to be a strong predictor of various behaviors across several different behavior theories/models, including Social Cognitive Theory, the Theory of Reasoned Action, Theory of Planned Behavior, and the HBM (AbuSabha et al., 1997). It has been applied to numerous health behaviors, including physical activity, dietary habits, sexual risk behaviors, and breast self-examination, among others (Pinto and Floyd, 2008; Lin et al., 2005; Norman et al., 2005).

In addition to the main HBM constructs described above, the HBM has been conceptualized to contain a series of modifying factors that facilitate the process of assessing perceived threat and determining the likelihood of action. These modifying factors interact with an individual's perceptions about the focal health condition or disease and include: demographic variables such as socioeconomic status, gender, age, race, and ethnicity; psychological variables such as personality type; and, structural variables such as prior experience with disease and knowledge of disease (Rosenstock, 1974; Green and Glanz, 1995; Champion and Skinner, 2008; Painter et al., 2008, Hall, 2011). Specifically, the modifying factors are intended to serve as either mediators or moderators of the relationship between selected HBM constructs and the likelihood of an individual taking a particular action (Rosenstock, 1974). As described by Hall et al. (2011), the constructs emphasize such modifiable factors in order to facilitate tailored interventions to promote healthy behaviors. The mediating role of these modifying factors is important because it allows for more robust analysis of the direct effects of the core constructs by placing them in the context of such demographic variables as age, gender, income, and race (Fulton et al., 1991). Figure 2 provides an illustration of the HBM.

2.3.3 Measurement of HBM Constructs

Measurement of each of the HBM constructs can prove challenging and complex. Conventionally, perceived susceptibility and perceived severity are measured in combination as perceived threat from a specific disease or health condition. This measurement involves development of a combinatorial model based on the product of the two constructs: Perceived susceptibility x Perceived Severity = Perceived Threat (Glanz, 2008). Perceived threat has been demonstrated to be a consistent predictor of certain behaviors such as infection control, influenza immunization and cancer screening (Wong et al., 2005; Wolf et al., 2008; Flood et al., 2010; Tavafian, 2012).

According to Glanz et al. (2008), an elevated state of (perceived) severity is needed in order for perceived susceptibility to become a strong predictor of behavior. Within the context of high perceived severity, the authors explain, perceived susceptibility will become a stronger predictor of an individual’s intention to engage in a specific health-related behavior, such as WNV prevention measures (Champion and Skinner, 2008). This refers to a relationship between the two constructs wherein an individual's perception of his/her vulnerability to contracting a disease is impacted by the perception of its seriousness (Galloway, 2003). The collective perceived threat is described as the degree of the overall health threat combined with the person's confidence that the target behavior will ameliorate that threat (Galloway, 2003).



Source: Glanz; Champion and Skinner (2008)

Figure 2. Health Belief Model

2.3.4 Strengths and Weaknesses of HBM

Strengths

Given its history as one of the oldest conceptual models of health behavior, the HBM has been the subject of quite a few studies critiquing its effectiveness at explaining and/or predicting individual health behaviors. Early reviews of the model, such as Janz and Becker's (1984) review of 46 studies involving the HBM, provided considerable empirical support for the model, concluding that it is highly useful for examining preventive behavior (actions taken to avoid illness) over sick-role behavior (actions taken to restore health after diagnosis of a medical condition) and that its constructs represent valuable contributors to the prediction and explanation of individual health behaviors. More recent reviews have supported the assertion that perceived barriers are, in fact, one of the strongest predictors of behavior. A key contribution of the HBM to the behavioral sciences is its focus on personal perceptions as key constructs and determinants of individual behavior (Champion and Skinner, 2008; Elder et al., 1999; Walker, 1999). Specifically, the main strength of the HBM has been identified as its “common sense operationalization” that focuses on beliefs pertaining to decisions about individual health behaviors (Conner, 2010). The HBM constructs operationalize the manner in which individuals incorporate their knowledge, beliefs, and attitudes toward a behavior into a cost/benefit analysis of the pros and cons of engaging in it (Conner, 2010; NCI, 2005).

Additional strengths of the HBM include its diverse applicability to various ethnic groups and its utility for explaining or predicting habitual behaviors such as mammography, medication adherence, or substance use (Conner, 2010; Pasick et al., 2008).

Although it has been argued that a valid assessment of the effectiveness of the HBM constructs in predicting behavior can only be achieved through use of longitudinal studies, its validation has been inferred from cross-sectional study designs. Specifically, Carpenter noted in his review that there has been dissent among reviewers over the years regarding the capacity of the model to be used for examination of cross-sectional data (Carpenter, 2010). He noted that Rosenstock expressed concern about the validity of applying the HBM to cross-sectional data, due to the problem of subjects' perceptions changing over time and the potential to yield overestimates of relationships among variables. Janz and Becker (1984) argued the opposite, namely that cross-sectional associations would be weaker than those found in longitudinal studies.

Weaknesses

Despite its advantages, the HBM has been noted to have significant limitations as well. First, it assumes that people's actions are under volitional control, which may not always be the case. That is, the model operates most effectively when based on the assumption that a person's actions are habitual and are entirely voluntary (due to an individual's choice) such as condom use, exercise, and mammography screening (Wong et al., 2005; Calvocoressi et al., 2004; Deavenport et al., 2011). Conversely, addictive behaviors triggered by a physiological addiction such as substance abuse and smoking are less readily explained by the HBM as a whole, and may only be accurately predicted by select constructs from the HBM and other behavioral models (Bonar et al., 2011; Schofield et al. 2007). Second, although the model has been demonstrated to have good explanatory power for certain behaviors, its effectiveness tends to vary depending on the specific health threat (Greene et al., 2003). For example, susceptibility, severity and cues to action have all been suggested to be poor predictors of condom use, but strong predictors of influenza vaccination (Reid et al., 2011; Flood et al., 2010). Third, the model fails to distinguish between first time and repeat behaviors.

In addition, a number of challenges have emerged in the effort to develop suitable scales for measurement of HBM concepts. These scale development efforts have been plagued by such problems as inconsistency with theory, measurement error, and failure to account for the temporality of relationships (Glanz, 2008).

Some studies have indicated that the HBM has very limited utility for explaining the variance in certain populations for selected behaviors, such as condom use and other sexual practices among college students (Lollis et al., 1997) and that it has limited predictive power overall (Yarbrough et al., 2001).

Galloway suggested that the HBM is based on the premise that behavior is prompted by a desire to avoid disease or illness, unlike other models such as the Health Promotion Model, which promotes enjoyment or satisfaction with one's health status (Galloway, 2003). Beyond the assertion that it is a model of avoidance behavior, he further added that the HBM is "merely an articulation of variables affecting behavior," implying that the model lacks cohesion as a viable tool to predict behavior (Galloway, 2003). Roden echoed this sentiment in her critique of the HBM, stating that the model is limited by its "unclear construct and relationship development" (Roden, 2004). It has been further suggested that the HBM has little or no capacity for predicting long-term health behaviors (Jones et al., 2013).

Furthermore, a number of studies have suggested that the HBM explains only a small proportion of the total variance in an analysis of behavior, implying that it is not a useful model for predicting behaviors (Lollis et al., 1997). To that end, Mattson et al. have proposed re-conceptualizing the HBM to place the cues to action at the center, such that they mediate the other constructs (Mattson et al., 1999).

As noted earlier, there is also disagreement among researchers as to which HBM construct is the most effective predictor of behavior, as this often varies by disease outcome (Greene & Brinn, 2003). For example, while several studies have suggested that perceived barriers are the most powerful predictor of behavior (Mahoney et al., 1995; Atkinson et al., 2009), Swaim et al. pointed out that this is only true for "one-shot" behaviors such as vaccination and screening exams, while for behaviors practiced over the long term, like dietary habits, dental hygiene and exercise, self-efficacy emerges as the best predictor (Swaim et al., 2008; DeBate et al., 2006). Further support for that assertion was articulated by Fulton and colleagues, who stated that the model's utility was unclear for long-term behaviors that involve lifestyle changes (Fulton et al., 1991). Conversely, Mahoney et al. have asserted that perceived barriers remain the most useful predictor of behavior, followed in order by benefits, susceptibility, and severity (Mahoney et al., 1995). Despite some research studies which have suggested that perceived susceptibility and perceived severity are both among the strongest predictors of preventive health behaviors, the latter has sometimes been shown to be inconsistent at predicting some health behaviors (Yarbrough et al., 2001).

Despite these limitations, the HBM remains a widely used theory. It is an appropriate theoretical framework for development of a survey instrument to examine West Nile Virus prevention behaviors in older adults in Maryland. As previously mentioned, it has been applied in other research on WNV protective behaviors. Moreover the HBM, as will be described subsequently, has demonstrated utility in explaining individuals' behaviors for a variety of other infectious diseases.

2.3.5 Applications of the Health Belief Model

Following its original use in the context of evaluating TB screening behaviors, the model has subsequently been applied to a variety of health behaviors including mammography screening, vaccination compliance, adherence to medication regimens, and engagement in safe sex behaviors (Janz and Becker, 1984; Glanz, 2008). The HBM has also been used to explain behavior with respect to a number of chronic diseases, such as cancer (including breast, cervical, and prostate cancer), and related screening behaviors (Calvocoressi et al., 2004; McQueen et al., 2010; Deavenport et al., 2011).

2.3.6 Health Belief Model and Communicable Diseases

The HBM has also been used as a theoretical framework to guide interventions and exploratory focus group studies for various communicable diseases, including Dengue Hemorrhagic Fever (Phuanukoonon et al., 2006), human papillomavirus (HPV) (Krawczyk et al., 2012; Reiter et al., 2009), Influenza A (Flu), MRSA, rotavirus (Morin et al., 2012), vancomycin-resistant enterococcus (Curry and Cole, 2001) and assorted zoonoses (diseases transmitted between vertebrate animals and humans) (Bosch et al., 2010). This suggests that the model may have utility in explaining individual behaviors related to risk and transmission of these and other communicable diseases.

2.4 Health Belief Model and West Nile Virus Prevention

Although the HBM has been applied to the study of preventive behaviors for selected communicable diseases, its use in arboviral disease research has been limited. A small body of social science research has considered the application of health behavior theories and models to WNV prevention, but there remains a paucity of research that explores the application of such theoretical constructs to the prevention of WNV and other mosquito-borne diseases. A limited number of studies have examined individuals' attitudes, perceptions, and/or knowledge about WNV disease perception, and a small proportion of those have applied a theoretical framework to that analysis.

With respect to WNV prevention, the Health Belief Model can be constructed as follows:

- *Perceived susceptibility* to West Nile Virus refers to a person's belief that s/he is vulnerable to WNV infection; this can be a key component of his/her intention to take action to prevent it. This can be challenging to measure however, as not all members of the target population (adults over 60 years of age) are aware of the risks associated with WNV infection.
- *Perceived severity* of West Nile Virus refers to how serious an individual considers WNV to be; they may or may not recognize that it can cause severe neurologic disease resulting in significant morbidity and/or death. This is particularly relevant for persons aged 50 and over as they are at greatest risk of severe illness and death from WNV infection.
- *Perceived benefits* of WNV protective behaviors can include a variety of positive outcomes associated with engaging in the preventative behaviors; such benefits can include avoidance of infection, illness, and hospitalization as well as greater confidence in ability to protect ones' self from the disease.
- *Perceived barriers* to WNV protective behaviors refer to any factor that impedes a person from engaging in WNV protective behaviors; barriers can include financial limitations that prevent a person, lack of education about the appropriate

repellents to use or how to use them, and/or physical limitations that may prevent a person from regularly draining areas of standing water on their property.

- *Cues to action* are particular events or messages th*at prompt an* individual to engage in personal protective behaviors; they can include learning of an acquaintance that has been diagnosed with WNV disease, hearing public health alerts about WNV on the news, or receiving information about it from a health care provider.
- *Self-efficacy* for WNV prevention refers to the extent to which a person feels confident that s/he is capable of performing the steps needed to avoid WNV infection (such as using insect repellent, dressing appropriately when outdoors, avoiding the outdoors during mosquito feeding hours, and routinely emptying items containing standing water).

2.5 Central Themes in West Nile Virus Prevention Behavior Literature

Some key themes have emerged in the existing literature regarding assessment of people's knowledge, attitudes, and behaviors toward WNV prevention. Some studies incorporated a theoretical/conceptual framework while others did not. Some of the earliest studies examined individuals' knowledge, attitudes, and behaviors related to WNV, either immediately preceding or immediately following two of the largest WNV epidemics nationwide in 2002 and 2003. These studies took the form of retrospective analyses or cross-sectional designs and included serosurveys to determine exposure to WNV as well as assessment of people's attitudes and behaviors toward the virus. Given the widespread impact of WNV outbreaks affecting all of North America, researchers in both the U.S. and Canada began to analyze the interrelationships between people's knowledge, attitudes and their behaviors to reduce their risk of WNV infection. A discussion of these studies and their main findings are summarized in Table 1 and described in more detail below.

Table 1. Summary of Studies on West Nile Virus Knowledge, Attitudes, and Behavior

Year	Name of study	Authors	Study design	Theoretical model	Constructs	Findings
2001	WNV Serosurvey and Assessment of Personal Prevention Efforts in Area with Intense Epizootic Activity, 2000	McCarthy et al.	Household survey and serosampling of CT residents aged 12 and older	None	N/A	High WNV awareness; female gender and high perceived risk associated with practicing 2 or more PPBs; adults >50 less likely to practice PPBs
2003	Knowledge, Attitudes, and Behaviors about WNV—Connecticut, 2002	Adams et al.	Cross-sectional; telephone survey; CT residents aged ≥ 18 years	None	N/A	People over 50 more likely than younger adults to always use at least 1 PPB. Use of PPBs highly associated w/ female gender, age ≥ 65, and upper income
2003	Pre-WNV Outbreak: Perceptions and Practices	Herrington et al.	Cross-sectional; nationally representative survey	Health Belief Model	Perceived susceptibility; perceived severity	Perceived susceptibility to repellent toxicity outweighed vulnerability to disease
2003	Current Knowledge, Practices, and Attitudes of Miami-Dade Residents about WNV Disease and its Prevention	Leguen et al.	Cross-sectional CATI survey of adults 18 and over in Miami-Dade County	None	N/A	Most respondents familiar with WNV; nearly half use insect repellent; 20% believe WNV not a serious health threat

Year	Name of study	Authors	Study design	Theoretical model	Constructs	Findings
2004	WNV in British Columbia	Aquino et al.	Cross-sectional; telephone survey	Health Belief Model	Perceived susceptibility, severity, barriers, benefits, cues to action	Perceived hazard of DEET, time needed to drain standing water are major barriers
2004	WNV: Knowledge, Behaviors, Attitudes Among Seniors, Denton County, Texas	Henry et al.	Focus groups and face-to-face interviews with Denton County residents aged 50 and older	None	N/A	Most respondents knowledgeable; lack of familiarity with symptoms; majority recognized that WNV can be fatal; few practice PPBs
2005	Evaluation of West Nile Virus Education Campaign	Averett et al.	Cross-sectional; telephone survey of KS residents and media survey of news outlets	None	N/A	Most respondents knowledgeable about WNV risk; mass media and word of mouth most successful methods of WNV info dissemination
2005	What Seniors Say About WNV: The Threat is Not Over	Bitto et al.	Cross-sectional survey and qualitative evaluation of educational intervention	Health Belief Model	Perceived susceptibility, severity, barriers, self-efficacy, cues to action	Most seniors motivated to use PPBs; Lack of self-efficacy and perceived barriers were common among seniors who had problems using insect repellent
2005	Heeding the Message? Determinants of Risk Behaviours for West Nile Virus	Wilson et al.	Cross-sectional telephone survey	None	N/A	Nearly ¼ of respondents had not heard of WNV and almost half thought it was an unimportant health issue; fewer urban residents used DEET; nearly 1/3 do not routinely drain standing water

Year	Name of study	Authors	Study design	Theoretical model	Constructs	Findings
2006	The Effect of Health Communication on a Statewide WNV Public Health Education Campaign	Fox et al.	Cross-sectional; telephone survey of adult KS residents	None	N/A	Men more likely respond to radio ads, while women prefer brochures and literature; Internet is effective tool; older adults fixed window screens more often than younger adults
2006	Seroprevalence of WNV in Saskatchewan's Five Hills Health Region	Schellenberg et al.	Cross-sectional phone survey & seroprevalence study; adults 18 years and over	None	N/A	Good knowledge of WNV and prevention methods; odds of being WNV+ were 6x higher for rural residents
2007	Behavioral Risks for WNV Disease, Northern Colorado, 2003	Gujral et al.	Cross-sectional telephone survey of adults 18 and over	None	N/A	Fort Collins residents more likely than Loveland residents to use DEET; older persons seldom use DEET; those with low income seldom practice PPBs; those not worried about WNV rarely practice PPBs
2007	Exposure to WNV during the 2002 Epidemic in Cuyahoga County, Ohio: A Comparison of Pediatric and Adult Behaviors	LaBeaud et al.	Cross-sectional household survey	None	N/A	Children had higher outdoor exposure than adults; both children and adults educated about WNV; subjects more worried about WNV infection than pesticide use
2007	The Validation of a WNV Survey Based	Yerby	Qualitative	Health Belief Model	Perceived susceptibility, severity, benefits,	Modified survey instrument validated; all

Year	Name of study	Authors	Study design	Theoretical model	Constructs	Findings
	on the Health Belief Model				barriers, cues to action, self-efficacy	constructs except Perceived Barriers to Repellent use predicted personal protective behavior
2008	West Nile Virus: The Buzz on Ottawa Residents' Awareness, Attitudes, and Practices	Elliott et al.	Cross-sectional telephone survey	None	N/A	WNV awareness and worry very high; female gender and concern for WNV predicted practice of PPBs
2008	Self-reported Protective Behaviour Against WNV Among Pregnant Women in Toronto	Kiehn et al.	Cross-sectional survey of pregnant clients at outpatient obstetric clinics	None	N/A	High awareness of WNV and transmission; more pregnant women practiced 2 or more PPBs than general population; major concerns about hazardous effects of insect repellent on baby; worry about WNV infection during pregnancy
2009	Knowledge, Perceptions, and Practices: Mosquito-borne Disease Transmission in Southwest Virginia	Butterworth	Cross-sectional; in-person survey	Health Belief Model	Perceived susceptibility, severity, benefits, and barriers	Gender predicted knowledge; perceived hazards of repellent significant barrier; removing standing water best way to avoid mosquito bites
2009	Public Health Responses to	Elmieh	Cross sectional;	Health Belief	Perceived susceptibility,	WNV risk perception

Year	Name of study	Authors	Study design	Theoretical model	Constructs	Findings
	WNV: The Role of Risk Perceptions and Behavioral Uncertainty in Risk Communication and Policy		telephone survey	Model	severity, benefits, barriers, cues to action, self-efficacy	varied with age, gender, and household location; laypeople more willing to trade-off risk than experts
2009	Effect of WNV Perceptions and Knowledge on Protective Behavior and Mosquito Breeding in Residential Yards in Upstate New York	Tuiten et al.	Cross-sectional KAP survey and entomological survey via property inspection	None	N/A	Most respondents knowledgeable about WNV transmission and risk groups; fear of repellent was major barrier; no association between WNV knowledge and mosquito production on property
2011	Public Attitudes, Knowledge and Practices on West Nile Virus	Eichler	Cross-sectional telephone survey	Health Belief Model	Perceived susceptibility, severity, benefits, barriers, cues to action, self-efficacy	WNV knowledge and concern did not predict PPB practice; older age predicted increased PPB use

U.S. Studies of WNV Protective Behavior

Herrington et al. (2003) administered a nationally representative survey instrument to a primary sample of 1500 adults plus an oversample of an additional 250 adults in six states to describe the prevalence of adults' perceptions and practices prior to the first outbreak of WNV in 1999. The survey instrument used selected constructs from the HBM (perceived susceptibility and perceived severity) and selected other behavioral variables from other theories. They found that one-third of all respondents perceived use of insect repellent on skin, staying indoors during peak mosquito hours, and wearing long sleeves and long pants as the most effective measures for preventing WNV (Herrington et al., 2003). Results also suggested that, for many individuals, the perceived susceptibility to toxicity from insect repellent outweighed their perceived susceptibility to WNV encephalitis. However, concern about being bitten by mosquitoes (perceived susceptibility to mosquito bites) was the most significant predictor of actions to prevent such bites (Herrington et al., 2003).

In another one of the earliest studies conducted immediately after the 2002 WNV outbreak in the US, Connecticut state health officials, in collaboration with CDC, administered a random-digit-dialed telephone survey to Connecticut residents aged ≥ 18 years old (Adams et al., 2003). Staff at the Connecticut Department of Public Health modified the state's existing Behavioral Risk Factor Surveillance System (BRFSS) survey to include items asking about individuals' knowledge, awareness, attitudes and behaviors toward WNV prevention. They identified significant associations between female gender and practice of two or more personal protective behaviors (PPBs) as well as between worry about getting WNV infection and practice of PPBs. Findings suggested that awareness and knowledge of the severity of WNV were high among elderly individuals (Adams et al., 2003). Most notably, respondents aged 50 years of age and older were more likely to always practice at least one personal protective behavior than younger respondents (aged 18-49 years old) (Adams et al., 2003). Their results suggest that adults in the high-risk (over 50) age group are acutely aware of their own susceptibility to WNV disease.

Gujral et al. (2007) administered a telephone survey to Colorado residents in two adjacent cities, following the 2003 WNV outbreak, to assess their personal protective behaviors. They determined that greater exposure to the outdoors during mosquito feeding times and lower use of insect repellent both contributed to the incidence of WNV neuroinvasive disease (Gujral et al., 2007). They also found that older adults and those not concerned about WNV infection were less likely to use insect repellent containing DEET. However, perceived risk (threat) of WNV disease was determined to be a consistent predictor across all age groups. Like many studies, this one was somewhat limited by both recall and reporting bias, as it was administered several months after a WNV outbreak, but such impacts were considered minimal (Gujral et al. 2007).

LaBeaud and colleagues (2007) conducted a survey to compare WNV knowledge and behaviors between adult and pediatric populations in Cuyahoga County, Ohio during the 2002 WNV epidemic. A questionnaire was administered to residents of randomly-selected households during summer 2002. Seropositivity of participants was measured through blood sampling. While both populations were well informed about WNV, television, rather than health care providers, served as participants' primary means for obtaining WNV education. Furthermore, children tended to spend more time outdoors than adults and were far less likely to wear protective clothing such as long sleeves and long pants when outside. As a result, children tended to experience more mosquito exposure. Children's attitudes toward WNV risk were essentially similar to those of their parents (LaBeaud et al., 2007).

Only one study has exclusively examined attitudes and behaviors toward WNV among adults over 50 years of age. Bitto and colleagues (2005) developed and implemented a tailored health education intervention among senior citizens in Monroe County, PA in an effort to educate this high-risk group and to counter widespread myths and misperceptions about WNV disease in the general population. The authors partnered with local health officials and senior clubs to conduct a series of training sessions and group discussions and to administer a descriptive survey that captured respondents' demographic information as well as their knowledge, attitudes, and practices regarding WNV prevention (Bitto et al. 2005). They determined that several of the HBM constructs were predictive of WNV protective behavior in elderly populations; namely perceived threat (susceptibility and severity) and perceived benefits and barriers, all of which were associated with reduced WNV risk behavior (Bitto et al., 2005).

In 2009, Tuiten et al. conducted the first study that combined a Knowledge, Attitudes, and Practice (KAP) survey with an entomological survey of residential mosquito breeding sites. As with other studies, most respondents demonstrated acceptable knowledge of the risk factors, transmission, and prevention measures for WNV. Fear of the odor and toxicity of insect repellents was again found to be a significant perceived barrier to their use.

Two research studies specifically sought to assess the impact and effectiveness of WNV public education campaigns on selected communities. Both Averett et al. (2005) and Fox et al. (2006) conducted surveys to assess Kansas residents' knowledge, attitudes, and behaviors following a statewide WNV education campaign. While both studies revealed that the majority of respondents were familiar with WNV, its risk groups, and modes of transmission, perceived risk of acquiring WNV disease remained surprisingly low (Averett et al., 2005).

Canadian Studies of WNV Protective Behavior

Aquino et al. (2004) developed a questionnaire based on the HBM and administered it to 309 Canadian residents to examine determinants of engaging in WNV protective behaviors. They found that the most significant barrier to engaging in such behavior was the belief that DEET is a major health and environmental hazard. They also identified knowledge deficiencies among respondents, particularly in regards to the groups at greatest risk of severe WNV disease (adults over 50 years old) and determined that increasing perceived susceptibility and perceived severity to match actual susceptibility and severity could benefit this population (Aquino et al., 2004). Finally, it was concluded that dissemination of WNV prevention information via TV and other media increased respondents' odds of practicing protective behaviors more frequently. Like the Herrington (2003) study, the Aquino study also found that potential health hazards of insect repellent containing DEET were a significant barrier to practicing that and other protective behaviors.

Likewise, Elliott et al. (2008) conducted a telephone survey of Ontario residents in spring 2003 to assess their uptake of public health messaging following the 2002 WNV outbreak. They discovered that despite high levels of awareness of WNV disease risk that actual practice of PPBs was surprisingly low, suggesting a need to revise risk communication strategies to reinforce the severity and public health impact of WNV disease.

In another study of Canadian populations, Schellenberg et al. (2006) conducted a cross-sectional prevalence study to assess seroprevalence as well as knowledge, attitudes, and behaviors among residents in an area of Saskatchewan that reported the highest number of WNV human cases per capita in summer 2003. Results revealed an overall good knowledge of methods of prevention and transmission of WNV. Also, age disparities regarding select behavioral practices were detected, i.e., persons over 60 years old were less likely to use repellent containing DEET as compared to their younger counterparts.

Following the discovery of alternate yet rare modes of WNV transmission (e.g., organ donation, blood transfusion, breastfeeding, and intrauterine transmission), a number of researchers undertook studies of these special populations. In 2005, a single case of WNV during pregnancy with long-term fetal sequelae was noted (Kiehn et al., 2008). In 2006, Kiehn et al. conducted a cross-sectional survey of WNV protective behaviors among a sample of pregnant women in Toronto and found that the majority of them practiced protective behaviors to avoid mosquito bites (Kiehn et al., 2008). However, similar to respondents in other behavioral studies, they expressed considerable concern about the safety of using insect repellents (while pregnant).

Doctoral Dissertation Research and Theses examining WNV Prevention Behavior

In addition to the published, peer-reviewed studies of WNV health behaviors described above, a number of graduate student researchers conducting thesis or dissertation work have also examined the application of the HBM to the development and implementation of survey instruments for the purpose of assessing individuals' knowledge, perceptions and behaviors relative to prevention of WNV and other mosquito-borne diseases.

One of the earliest such research studies completed during doctoral study was a validation of a WNV survey instrument. In her 2007 dissertation, Yerby modified an existing Canadian WNV survey instrument that was based on the HBM and validated it among a sample of women in the Southeastern states. Specifically, the survey captured West Nile virus knowledge, attitudes, and personal protective behaviors (PPB) among women 19 years old and over living in West Alabama in an effort to determine if the HBM constructs predicted their practice of PPBs, as well as to gather information about that group's knowledge, attitudes, and practices surrounding WNV and to formulate educational programs for the future. The multi-stage validation process involved a five-step process that included expert panel review, face-to-face interviews, focus groups, pilot testing of the instrument, and statistical analysis (Yerby, 2007). Her efforts ultimately resulted in the creation of an instrument that was judged to be both valid and reliable for assessing the perceptions and WNV prevention behaviors of women (Yerby, 2007). Yerby found that all construct factors, with the exception of Perceived Barriers to Repellent Use were predictive of personal protective behaviors. Her dissertation resulted in the first formally validated theory-based survey instrument for capturing WNV prevention behaviors. In contrast to Yerby's study, which focused on women 19 years old and over in southern Alabama, this study was the first to examine the WNV preventive behaviors of high-risk adults (men and women) in Maryland.

In 2009, Butterworth conducted a cross-sectional survey study to examine the relationship between selected demographic and socioeconomic variables and individual perceptions of mosquito-borne diseases in two Virginia counties (Butterworth, 2009). This research was conducted within a disease ecology framework, using the HBM as a theoretical framework, and applying principles of medical geography to analyze human-mosquito interactions and consider the impact of behaviors on disease prevention

(Butterworth, 2009). Study findings suggested that concerns about susceptibility to and severity of mosquito-borne disease varied significantly by gender and other factors, with women demonstrating greater perceived susceptibility than men and stronger belief that such diseases require medical attention. Lack of time was the most significant barrier preventing respondents from emptying areas of standing water around their properties. In addition, a perception of physical hazards associated with insect repellent use emerged as a major barrier to their use. A number of potential benefits from having greater accessibility to WNV prevention information online were also identified, and suggestions made to incorporate this into the Virginia Health Department web pages. While Butterworth's study focused on a disease ecology framework to examine WNV behaviors in Virginia residents, it did not consider the specific perceptions and barriers experienced by older adults in that region. Accordingly, this dissertation examined knowledge, attitudes and behaviors toward WNV prevention among a specific sample of adults 60 years of age and older in Maryland, who are at greatest risk of severe disease.

In the same year, Negar Elmieh (2009) examined risk perceptions, risk communication, and behavioral uncertainties related to WNV prevention and control among residents of British Columbia, Alberta, and Manitoba, Canada. The HBM was used as a theoretical framework to frame some of the research questions, which sought to determine which health beliefs influenced respondents' engagement in recommended WNV risk reduction behaviors and how those behaviors varied according to potential WNV exposure and demographic variables. Perceived barriers were significantly associated with all outcomes except that of wearing protective clothing (long sleeves and long pants) (Elmieh, 2009). Specifically, study participants were less likely to use window screens, avoid the outdoors during dusk and dawn, or initiate source reduction behaviors (draining items containing standing water). Of particular interest was the finding regarding perceived susceptibility to WNV infection. Respondents' perception of their own risk of acquiring the disease was driven not only by the actions they chose to take (or not take) but also by their immediate environment: they felt varying amounts of vulnerability to getting infected at home versus outside during seasonal recreational activities. Elmieh inferred from this finding that future WNV educational materials could be tailored to address such concerns by specifically targeting each area (creating flyers that promote use of window and door screens to prevent mosquito exposure at home and bulletin boards and billboards posted at public parks and other public outdoor venues).

Similarly, Eichler (2011) developed an original survey to examine public attitudes, knowledge, and behavior practices toward WNV in Delaware County, PA. Results revealed high levels of knowledge of personal protective behaviors (PPBs) among the sample and an apparent association between perceived susceptibility and PPB use as well as between age and PPB use and education and pesticide use (Eichler, 2011). The Eichler study was broad in that it sampled a population of adults of all ages without focusing on those adults at highest risk of severe WNV disease. In contrast, this study specifically examined beliefs, perceptions, and behaviors of high-risk adults over 60 years old in Maryland.

Only seven of the above studies specifically incorporated use of the HBM to study WNV PPBs in different samples/populations. Table 2 below summarizes those studies in greater detail, and includes the HBM constructs examined, study findings, strengths and weaknesses, and application to public health practice.

Table 2. Summary of Studies Using the HBM to Examine WNV Personal Protective Behaviors

Title	Authors	Population	Study design	Constructs	Findings	Strengths & Weaknesses	Practice Application
Pre-WNV Outbreak: Perceptions and Practices	Herrington, 2003	Nationwide sample of 1500 adults; oversample of 250 residents in NE states	Cross-sectional; nationally representative survey	Perceived susceptibility; perceived severity	Perceived susceptibility to repellent toxicity outweighed vulnerability to disease	Nationally representative sample; self-report data; cross-sectional design (lack of temporality)	Development of future longitudinal studies of WNV behavior in MD residents
WNV in British Columbia	Aquino et al., 2004	Adult residents of British Columbia	Cross-sectional; telephone survey	Perceived susceptibility, severity, barriers, benefits, cues to action	Perceived hazard of DEET, time to drain standing water are major barriers	Tailored questionnaire designed for study; self-report data; no info on non-respondents	Basis for design of educational interventions to promote practice of 4 D's in Maryland
What Seniors Say About WNV: The Threat is Not Over	Bitto et al., 2005	Adults ≥ 50 yrs old	Cross-sectional survey and qualitative evaluation of educational intervention	Perceived susceptibility, severity, barriers, self-efficacy, cues to action	Most seniors motivated to use PPBs; Lack of self-efficacy and perceived barriers were common among seniors who had problems using insect repellent	Epidemiologic triad as conceptual model; qualitative design	Basis for development of interventions to increase personal protective behaviors among adults > 50 yo and older
The Validation of a WNV Survey Based on the Health Belief Model	Yerby, 2007	Women ≥19 yo in Alabama	Qualitative	Perceived susceptibility, severity, benefits, barriers, cues to action, self-efficacy	Modified survey instrument validated; all constructs except Perceived Barriers to Repellent use predicted personal protective behavior	First validated instrument for measuring WNV preventive behaviors; Convenience sample; limited to Southeastern US;	Model for validation study of MD WNV Barriers Study instrument
Knowledge, Perceptions, and Practices: Mosquito-borne Disease Transmission in Southwest Virginia	Butterworth, 2009	Adult residents of two counties in Southwest Virginia	Cross-sectional; in-person survey; short survey administered in-person at local post offices	Perceived susceptibility, severity, benefits, and barriers	Gender predicted knowledge; perceived hazards of repellent major barrier; removing standing	Strengths: Surveys administered during height of mosquito season Weaknesses: Social desirability bias during survey	Provide useful guide for local health departments under financial constraints, because findings

Title	Authors	Population	Study design	Constructs	Findings	Strengths & Weaknesses	Practice Application
					water best way to avoid mosquito bites	administration; recall bias	emphasize individual preventative actions
Public Health Responses to WNV: The Role of Risk Perceptions and Behavioral Uncertainty in Risk Communication and Policy	Elmieh, 2009	Adult Canadian residents	Cross sectional; online, mail, and telephone surveys of laypeople and health professionals	Perceived susceptibility, severity, benefits, barriers, cues to action, self-efficacy	WNV risk perception varied with age, gender, and household location; laypeople more willing to trade-off risk than experts	Actionable recommendations made according to type of planned intervention; Lengthy survey instrument; exploratory design	Guide for development of risk communication to target risk groups
Public Attitudes, Knowledge and Practices on West Nile Virus	Eichler, 2011	Adult residents of Delaware County, PA	Cross-sectional telephone survey	Perceived susceptibility, severity, benefits, barriers, cues to action, self-efficacy	WNV knowledge and concern did not predict PPB practice; older age predicted increased PPB use	Anonymous, self-administered survey; wide variety of venues for survey administration; convenience sample; predominantly female sample	Guide for revision of WNV educational literature to address specific knowledge gaps, particularly among high-risk adults

2.5.1 Strengths and Weaknesses of Existing Studies of WNV Protective Behavior

In summary, the above studies have consisted largely of cross-sectional study designs, along with large representative samples, randomized sampling procedures, and examination of a range of individual PPBs. Researchers captured knowledge, attitudes, and practices both before and after WNV outbreaks in the U.S. and Canada and some analyzed community-wide responses to targeted public education campaigns. Still, others conducted qualitative focus group sessions to understand perceptions of vulnerable populations (adults over 50) and to generate content for future interventions. Some have revealed a sometimes alarming lack of motivation or willingness to engage in key WNV protective behaviors, particularly among the group that needs it most (older adults). The findings suggest that use of a theoretical framework may have value at predicting the perceptions and behaviors of such high-risk individuals. Some weaknesses cited among the existing studies of WNV behavior have included use of self-reported data, recall bias, selection bias, and social desirability bias.

2.6 Conclusions

Collectively, the above research studies highlight some primary themes regarding engagement in WNV prevention behaviors. Specifically, although knowledge and awareness of WNV are often high, particularly among persons living in areas that have experienced large WNV epidemics, practice of PPBs remains low. This is often attributable to concern over potential harm or toxicity from insect repellent use (especially for vulnerable groups such as pregnant women and children), which often outweighs perceived susceptibility to the virus. Likewise, significant age disparities have been noted, with individuals over 50 years of age and at highest risk of severe disease often being less likely than their younger counterparts to engage in WNV PPBs. All of these findings warrant further study and none have been studied in Maryland residents, whose WNV knowledge, attitudes and behaviors may differ from those in other geographic areas previously studied.

Although previous studies have described the effectiveness of the HBM in explaining behaviors relevant to WNV prevention, such a behavioral analysis has not been previously conducted among Maryland residents over 60 years of age. Accordingly, using survey data gathered via the Maryland WNV Barriers Study the Maryland Department of Health and Mental Hygiene (DHMH), this study assessed the HBM as a theoretical framework to describe the knowledge, attitudes, and behaviors of Maryland residents 60 years of age and older regarding WNV disease. Given the gaps and needs highlighted in the above literature review, the application of secondary DHMH study data to an analysis of the effectiveness of the HBM in predicting WNV protective behavior among Marylanders identified important areas for targeted WNV prevention interventions among Maryland residents at least 60 years of age. The findings from this study will ultimately aid Maryland state health officials in the design and implementation of future educational interventions and could have broad applications in future theory-based research on WNV behavior.

CHAPTER 3: METHODOLOGY

3.1 Introduction

This dissertation presented a secondary data analysis of a cross-sectional study conducted by the Maryland Department of Health and Mental Hygiene (DHMH) in 2012. The study used telephone interviews to examine the knowledge, attitudes, and behaviors of a sample of Maryland adults 60 years of age and older toward West Nile Virus (WNV) prevention. The Health Belief Model (HBM) served as the theoretical framework for development of the survey instrument used in the study. This dissertation explored the utility of the HBM for predicting older adults' WNV prevention behavior. This chapter describes the study population, sampling and recruitment methods, survey development, survey implementation, theoretical basis, and statistical analysis plan for the dissertation study.

3.2 Population Description

For the cross-sectional study, adults aged 60 years old and older and living independently in Maryland were targeted as the sampling frame. Although national recommendations for West Nile Virus prevention focus on adults above 50 years old, who have been identified by the Centers for Disease Control and Prevention (CDC) as being at highest risk for severe WNV disease (CDC Factsheet, 2008), for purposes of this study, individuals aged 60 years old and older were selected.

People aged 60 years and over are more likely to have retired from work and to spend time at home or outdoors engaged in leisure-time activities that might bring them in contact with mosquitoes. They may also have greater financial limitations due to a fixed income that limits their ability to support local mosquito control programs.

Accordingly, this group was expected to be more accessible for telephone survey administration and was considered an important target for examination of attitudes and behaviors toward WNV.

Prospective subjects were sampled from Maryland counties in which at least two confirmed or probable human WNV cases had been reported during the previous six years. Case record review of human WNV cases reported in Maryland from 2006-2011 identified 11 zip codes from counties in which two or more confirmed or probable human WNV cases were reported to ArboNet, the national CDC database for electronic reporting of arboviral diseases. The CDC National Notifiable Diseases Surveillance System established the following case definitions for human WNV cases (CDC NNDSS, 2011): A confirmed WNV case is one that meets the clinical criteria for neuroinvasive or non-neuroinvasive disease along with specific laboratory criteria including virus isolation or a four-fold change in titer. A probable WNV case is one that meets the clinical criteria for neuroinvasive or non-neuroinvasive disease along with specific laboratory criteria consisting of virus-specific antibodies present in cerebrospinal fluid (CSF) or serum.

The study sample consisted of Maryland residents ≥60 years of age residing in zip codes in counties meeting the criteria. This study area comprises the following 11 zip codes: 20902, 20910, 21014, 21060, 21122, 21212, 21214, 21215, 21222, 21224, and 21228, which are found in Anne Arundel County, Baltimore City, Baltimore County, Harford County, and Montgomery County. Populations of residents 60 years old and older by age breakdown are shown in Table 3.

Table 3. Population of Maryland Residents ≥ 60 Years Old by Zip Code and Age Category

Zip Code/ Age	20902 (n)	20910 (n)	21014 (n)	21060 (n)	21122 (n)	21212 (n)	21214 (n)	21215 (n)	21222 (n)	21224 (n)	21228 (n)
60 to 64	2,325	1,998	2,145	1,627	3,465	1,908	1,142	3,542	3,115	1,966	2,882
65 to 69	1,607	1,216	1,511	1,193	2,531	1,321	730	2,771	2,299	1,451	2,016
70 to 74	1,187	805	1,060	936	1,610	923	458	2,291	1,847	1,079	1,496
75 to 80	932	598	976	770	1,133	715	359	1,961	1,644	980	1,515
80 to 84	784	489	809	566	798	617	319	1,565	1,303	778	1,650
85 & over	831	541	873	480	673	590	347	1,504	1,149	906	2,368

Source: US Census 2010

Eligibility and exclusion criteria for study participation are listed as follows:

Eligibility criteria

- Age ≥60 years old
- Living independently (single family home, apartment, retirement community, etc.)

Exclusion criteria

- Residing in long-term care facility, nursing home, or institution
- Non-English speaking

It was important to ensure that only healthy adults over 60 years who were ambulatory and living independently, without assistance, would be eligible to participate in the study. Exclusion criteria were chosen accordingly and also excluded anyone who did not speak English, as translation services were not available to conduct the telephone interviews in other languages.

Sample Size Determination

The research hypotheses for this study are listed in Table 4.

Table 4. Research Question and Hypotheses

Research Question	**Is the Health Belief Model a useful theoretical framework for predicting perceptions and behavior toward West Nile virus prevention among Maryland adults 60 years of age and older?**
1.	**Perceived susceptibility to WNV disease**
	Individuals with high perceived susceptibility to WNV infection are more likely to avoid going outdoors during mosquito feeding hours of dusk and dawn than individuals with low perceived susceptibility.
	Individuals with high perceived susceptibility to WNV infection are more likely to dress in long-sleeved shirts and long pants to avoid mosquito bites than individuals with low perceived susceptibility.
	Individuals with high perceived susceptibility to WNV infection are more likely to have used insect repellent in the last 90 days than individuals with low perceived susceptibility.
	Individuals with high perceived susceptibility to WNV infection are more likely to drain standing water from objects around their property that collect water than individuals with low perceived susceptibility.
	Individuals with high perceived susceptibility to WNV infection are more likely to accept a human WNV vaccine if one were available than individuals with low perceived susceptibility.
	Individuals with high perceived susceptibility to WNV infection are more likely to support mosquito control programs in their community than individuals with low perceived susceptibility.
2.	**Perceived severity of WNV disease**
	Individuals who perceive WNV as a severe disease are more likely to avoid going outdoors during mosquito feeding hours of dusk and dawn.
	Individuals who perceive WNV as a severe disease are more likely to dress in long-sleeved shirts and long pants to avoid mosquito bites.
	Individuals who perceive WNV as a severe disease are more likely to have used insect repellent in the last 90 days.
	Individuals who perceive WNV as a severe disease are more likely to drain standing water from objects around their property that collect water.
	Individuals who perceive WNV as a severe disease are more likely to accept a human WNV vaccine if one were available.
	Individuals who perceive WNV as a severe disease are more likely to support mosquito control programs in their community.
3.	**Perceived benefits of practicing WNV protective behaviors**
	Individuals who perceive benefits in practicing WNV protective behaviors are more likely to avoid going outdoors during mosquito feeding hours of dusk and dawn.
	Individuals who perceive benefits in practicing WNV protective behaviors are more likely to dress in long-sleeved shirts and long pants to avoid mosquito bites.
	Individuals who perceive benefits in practicing WNV protective behaviors are more likely to have used insect repellent in the last 90 days.
	Individuals who perceive benefits in practicing WNV protective behaviors are more likely to drain standing water from objects around their property that collect water.
	Individuals who perceive benefits in practicing WNV protective behaviors are more likely to accept a human WNV vaccine if one were available.
	Individuals who perceive benefits in practicing WNV protective behaviors are more likely to support mosquito control programs in their community.

4.	**Perceived barriers to practicing WNV protective behaviors**
	Individuals with high perceived barriers to practicing WNV protective behaviors are less likely to avoid going outdoors during mosquito feeding hours of dusk and dawn than individuals with low perceived barriers.
	Individuals with high perceived barriers to practicing WNV protective behaviors are less likely to dress in long-sleeved shirts and long pants to avoid mosquito bites than individuals with low perceived barriers.
	Individuals with high perceived barriers to practicing WNV protective behaviors are less likely to have used insect repellent in the last 90 days than individuals with low perceived barriers.
	Individuals with high perceived barriers to practicing WNV protective behaviors are less likely to drain standing water from objects around their property that collect water than individuals with low perceived barriers.
	Individuals with high perceived barriers to practicing WNV protective behaviors are less likely to accept a human WNV vaccine if one were available than individuals with low perceived barriers.
	Individuals with high perceived barriers to practicing WNV protective behaviors are less likely to support mosquito control programs in their community than individuals with low perceived barriers.
5.	**Cues to action for preventing WNV infection**
	Individuals who receive cues to action for preventing WNV infection are more likely to avoid going outdoors during mosquito feeding hours of dusk and dawn than individuals who do not receive cues to action.
	Individuals who receive cues to action for preventing WNV infection are more likely to dress in long-sleeved shirts and long pants to avoid mosquito bites than individuals who do not receive cues to action.
	Individuals who receive cues to action for preventing WNV infection are more likely to have used insect repellent in the last 90 days than individuals who do not receive cues to action.
	Individuals who receive cues to action for preventing WNV infection are more likely to drain standing water from objects around their property that collect water who do not receive cues to action.
	Individuals who receive cues to action for preventing WNV infection are more likely to accept a human WNV vaccine if one were available than those who do not receive cues to action.
	Individuals who receive cues to action for preventing WNV infection are more likely to support mosquito control programs in their community than those who do not receive cues to action.
6.	**Self-efficacy for preventing WNV infection**
	Individuals with high self-efficacy for preventing WNV infection are more likely to avoid going outdoors during mosquito feeding hours of dusk and dawn than individuals with low self-efficacy.
	Individuals with high self-efficacy for preventing WNV infection are more likely to dress in long-sleeved shirts and long pants to avoid mosquito bites than individuals with low self-efficacy.
	Individuals with high self-efficacy for preventing WNV infection are more likely to have used insect repellent in the last 90 days than individuals with low self-efficacy.
	Individuals with high self-efficacy for preventing WNV infection are more likely to drain standing water from objects around their property that collect water than

	individuals with low self-efficacy.
	Individuals with high self-efficacy for preventing WNV infection are more likely to accept a human WNV vaccine if one were available than individuals with low self-efficacy.
	Individuals with high self-efficacy for preventing WNV infection are more likely to support mosquito control programs in their community than individuals with low self-efficacy.

Conditional probability refers to the probability that an event will occur given the occurrence of another. In this study, the probability of a person being willing to accept a WNV vaccine, given his/her perception that WNV is a serious disease, was used as the basis for determining sample size. In previous published studies, perceived severity has not been found to be a significant predictor of most personal protective behaviors or attitudes toward WNV (Aquino et al., 2004; Herrington, 2004). Therefore, to calculate the sample size in this study, hypothesis 11, the probability that an individual who believes WNV can cause serious disease (an indication of perceived severity) will accept a WNV vaccine was assumed to have the lowest conditional probability. For all other hypotheses, the probabilities of the behavioral outcome occurring were higher and thus required smaller sample sizes. It was important to determine a sample size that would be sufficient to detect statistically significant differences in the relationship between HBM predictors and selected WNV attitudes and behaviors among study participants.

Although prior studies of the association between HBM constructs and WNV knowledge, attitudes, and behavior have not considered acceptance of WNV vaccine as an outcome, they have yielded findings of interest concerning other behavioral outcomes, which were used as a guide for this sample size determination. In her 2007 dissertation, Yerby found that individuals with a greater perceived severity score were 24% more likely to use DEET than those with a lower score (2007). This was the only instance in which perceived severity was determined to be a significant predictor of WNV behavior. Yerby also found that participants who perceived WNV as a serious disease had an odds ratio of 1.239 (p= 0.026) of engaging in at least one personal protective behavior (PPB). In their study of WNV knowledge, attitudes, and behaviors, Adams et al. (2003) found that Connecticut residents aged 65 years of age and older had nearly three times higher odds of always using at least one PPB compared to their younger counterparts: OR=2.6 (95%CI: 1.7-3.9). They also determined that individuals who had a high perceived susceptibility to WNV infection (those who were "very worried" about getting WNV) had two times higher odds of always practicing at least one PPB compared to those who were never worried [OR=2.2 (95%CI: 1.2-3.9)]. These odds ratios were believed to approximate the risk ratios (relative risk) of performing specific PPBs given perceived susceptibility and were also used as a basis for sample size calculation.

Based on these previously published findings, the sample size for this study was calculated incorporating the following parameters:

- The sampling frame (N): the number of Maryland adults aged 60 years old and older meeting eligibility criteria; N=34,000,
- Confidence interval: 95%
- Significance level: 0.05
- Power: 0.80

Null hypothesis: There is no difference in support for WNV vaccine between those individuals with high perceived severity of WNV disease and those with low perceived severity.

Alternative hypothesis: Adults with higher perceived severity of disease are more likely to accept a WNV vaccine than those who do not perceive the disease as serious.

The Type I error rate α was adjusted to hold for the primary hypotheses of interest and the Bonferroni adjustment was set to $\alpha=0.0167$ to guard against Type I error associated with multiple comparisons while maintaining the desired alpha level of 5%. Further, the desired power level was assumed to be 80% and that the hypothesis of interest was one-sided ($p_1/p_2>1$).

Based on the above, the following sample sizes were computed:

Relative Risk Ratio	Total Sample Size (n1=n2)	Type I Error (α)
1.5	484	0.0167
2.0	128	0.0172

Because we expected to detect a relative risk of 2.0 based on the risk ratio identified in the Adams study, the target number of potential enrollees to enroll was 128 for the three primary hypotheses, as indicated in the table above. However, because we also wished to examine the effect of additional variables, the target sample size was increased (doubled) to 256 households. This larger sample size would allow us to better examine the hypotheses within subsets of the study population, i.e. by race, ethnic group, income level, or geographic region.

3.3 Sampling Procedures

Figure 3 below shows a flowchart of the sampling procedures and data collection methods used for the study.

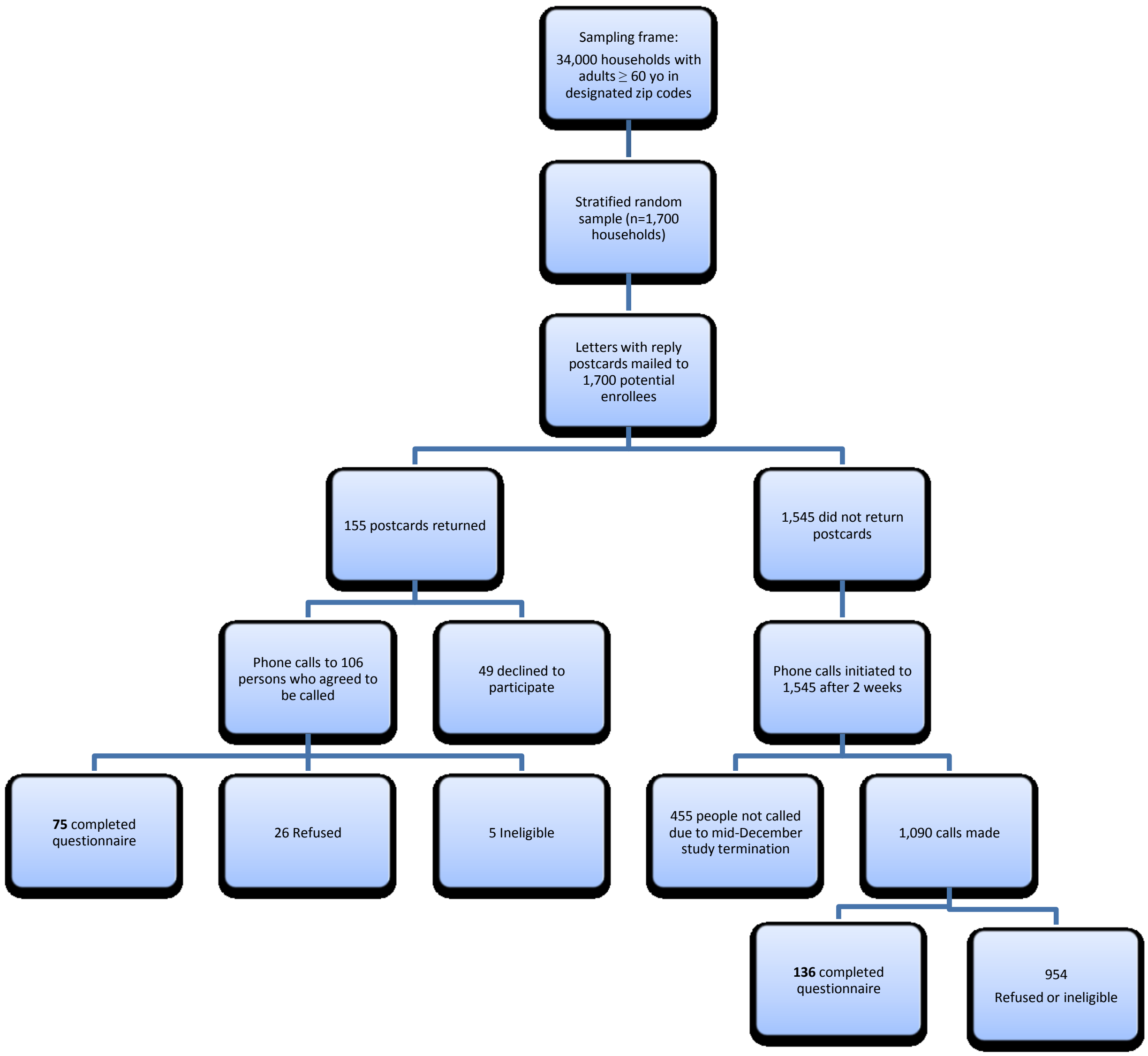


Figure 3. Diagram of Sampling and Data Collection Procedures

Sampling Frame

Potential enrollees were identified through a list of household telephone numbers obtained from Sales Genie, Inc. (www.salesgenie.com). Sales Genie, Inc. is a marketing company that provides marketing and data support services to business clients. The company supplies contact lists for marketing, research, and other projects through the use of data collected from various sources, including census records, voter registration files, deed and assessment property records, and business and consumer Yellow pages. DHMH staff purchased contact information for adults aged 60 years and older living independently in the zip codes identified above. For each zip code, the call list included households that fit the age and housing criteria and provided the following information: (1) Head of household; (2) Address; (3) County; (4) Phone number; and (5) Age. The list provided by Sales Genie, Inc. contained 34,000 records, which served as the sampling frame. Because telephone surveys often yield low response rates due to refusals or unavailability of potential enrollees, it was determined that study recruitment materials inviting prospective participants to enroll in the study should be sent to 1,700 households to increase the probability of achieving the targeted sample size.

Recruitment Process

Recruitment materials included an introductory letter describing the study and a postage-paid reply postcard with which prospective enrollees could indicate their willingness to be called We assigned a unique identification (ID) number to all prospective enrollees. The ID number was used to track whether individuals returned the reply postcards and was also used to generate a list of non-respondents. The study proposal, survey instrument, invitation letter, and related documents were approved by the DHMH Institutional Review Board in September 2012. Minor modifications to the instrument were submitted to and approved by the DHMH IRB in September 2012 following the original approval. The introductory letter and survey instrument are provided in Appendix A and Appendix C respectively.

Stratified Random Sample

Epidemiologists at DHMH applied stratified random sampling methods (households were stratified by zip code) using a computer-generated random number generator to generate a random sample of 1,700 households. As described in the sample size determination above, we aimed to recruit 256 participants from this sample of 1,700 households.

Survey Administration

Survey administration took place between October and December 2012. One individual was sampled per randomly selected household. The person to be surveyed was randomly selected by calling and asking for the household member who met the inclusion criteria and who had the most recent birthday. This was done to achieve random selection within each household, as in some instances the same person in a household routinely answers the phone, creating an internal bias. If the person with the most recent birthday was not at home, arrangements were made to call that person during a time that was more convenient to him/her. No other member of the household was interviewed as a proxy, if attempts to recontact the potential enrollee were unsuccessful. This approach aimed to avoid a within-household bias introduced by enrollment of an individual who did not meet the specific criteria. Every effort was made to call each household a total of six times, at varying times of day, depending on whether it was a weekday or weekend. Criteria that constitute valid attempts at phone contact are described in the Data Collection section.

Households Called and Enrolled

As described above, households that were randomly selected but in which the potential enrollee was unavailable, did not answer, or declined to participate were not replaced. It was anticipated that a sample of 256 adult Maryland residents $\geq$ 60 years old would be required to achieve a suitable effect size for detecting significant differences in respondents' reported personal protective behaviors according to their risk perceptions and self-efficacy. However, due to time constraints imposed by the approaching winter holiday season (and the likelihood that prospective enrollees would be unavailable or unable to recall their summer activities) survey administration had to be concluded in mid-December, prior to reaching the enrollment goal. The actual survey administration yielded a sample of 211 enrollees.

Introductory Letter

Each potential enrollee was mailed an introductory letter on official DHMH letterhead, introducing the study, before being contacted by telephone. Letters were mailed to the 1,700 households generated through the stratified random sampling procedures described above. See Appendix A for the introductory letter.

A postage-paid response postcard was enclosed with each letter, allowing potential enrollees the opportunity to refuse to participate prior to any attempt at telephone contact. If a potential participant indicated on the returned postcard a refusal to participate, his/her phone number was removed from the active call list. Potential participants could also return the postcard indicating a desire to participate by providing their phone number and the days and times that were convenient for them to receive calls.

If the potential participant did not respond to the postcard within two weeks, study personnel were instructed to accept this lack of response as permission to contact and proceeded to contact the participant for an interview. See Appendix B for the response postcard.

3.4 Theoretical Framework

The Health Belief Model (HBM) was created for the purpose of explaining an individual's engagement in a particular health behavior and provides a theoretical framework for describing individual health behaviors according to perceptions of the risks and benefits associated with the recommended behavior.

Developed in the 1950s by social scientists at the U.S. Public Health Service, the model was originally designed to understand the lack of participation in free TB screening programs and lack of compliance with public health recommendations (Hochbaum, 1958; Rosenstock, 1960, 1974; Carpenter, 2010). An outgrowth of stimulus-response theory and cognitive theory, the HBM was ultimately conceived as a value-expectancy theory, combining elements of both reinforcement-reward system as well as subjective personal judgments. As such, the HBM asserts that an individual seeks to avoid illness and that the person will engage in specific behaviors that enable him/her to avoid becoming sick (Carpenter, 2010).

The original HBM consisted of four core constructs: 1) perceived susceptibility (a person's belief that s/he is vulnerable to a certain disease/illness); 2) perceived severity (belief that the illness or disease, is serious and, if contracted, would have serious consequences illness); 3) perceived benefits (one's belief about the positive outcomes associated with actions taken to reduce susceptibility to or severity of a disease or illness); and,4) perceived barriers (potential negative outcomes associated with engaging in a particular health action to reduce the threat of disease). As research about the HBM evolved, cues to actions (internal or external stimuli that activate an individual's readiness to prevent disease) and self-efficacy were added. Self-efficacy (confidence in ability to perform the recommended health action), was added to the model in 1988.

Since its initial applications by the USPHS, the HBM has since been used as the basis for numerous interventions including mammography screening, AIDS prevention, and medication adherence (Carpenter, 2010; Champion & Skinner, 2008). Figure 4 presents a conceptual model of the HBM as it is applied to this WNV prevention study.

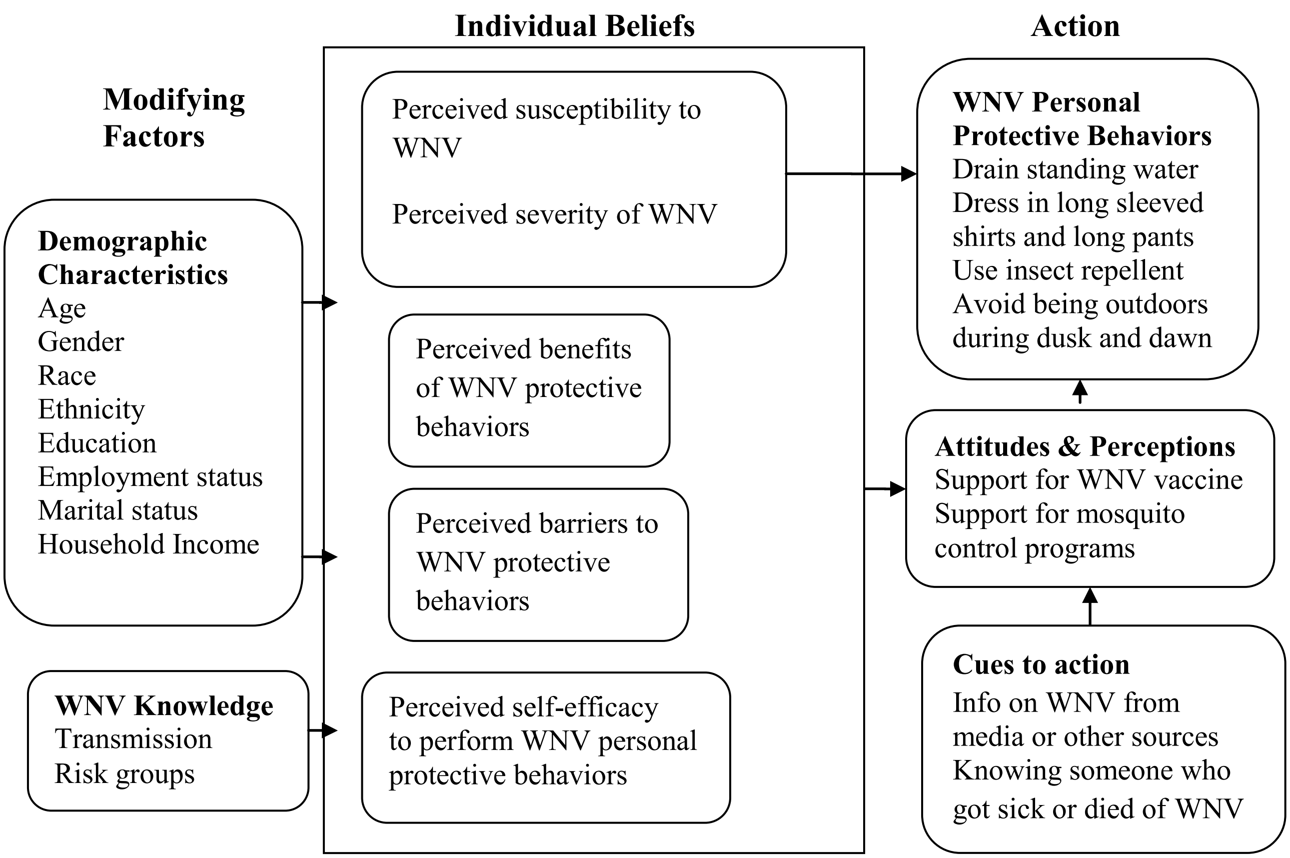


Diagram adapted from Champion and Skinner, in Glanz 2008.

Figure 4. Conceptual Model of Health Belief Model Applied to WNV Prevention

3.5 Study Design

The study was a cross-sectional design supported by the Emerging Infections Program of DHMH with funding from the Centers for Disease Control and Prevention Arboviral Disease group. It involved design and implementation of a telephone survey on a random sample of Maryland residents. The study protocol involved conceptualization of interview questions, training of interviewers, and development and pilot testing of the survey instrument on a small sample of Office of Infectious Disease Epidemiology and Outbreak Response staff members.

Survey Instrument

A 36-item questionnaire was developed expressly for use in the DHMH study. It was a new instrument adapted from the content of survey questionnaires used in previous studies of WNV behavior (Yerby, 2007; Aquino, 2004; Tuiten, 2009). Survey items were designed to capture respondents' knowledge, attitudes, and behavioral practices related to WNV prevention and were framed around similar items in WNV behavior studies by Aquino et al. (2004) and Tuiten et al. (2009). The survey instrument consisted of Likert scale and Likert-type items, yes/no questions, and open-ended questions.

Following development of the survey instrument, it was pilot tested with staff members in the Office of Infectious Disease Epidemiology and Outbreak Response, as they were a readily available convenience sample. This group of staff members was used in order to identify any challenges with survey administration. An expert reviewer from the Emerging Infections Program at DHMH with survey development experience also reviewed the pilot instrument and provided feedback, which was used to revise the instrument. Epidemiology staff who expressed interest in participating in survey administration were trained in interviewing techniques. Those trained interviewers administered the questionnaire via telephone interview to consenting enrollees from October through mid-December 2012.

The survey instrument included a detailed phone script which preceded the set of survey questions (see Appendix B). Interviewers were instructed to first ascertain that the respondent was at least 60 years of age, to then read a description of the survey, and if the respondent consented, to verify his/her eligibility by asking for the respondent's zip code and type of residence. Once it was established that the individual met the eligibility criteria and that s/he agreed to participate in the study, the interviewer commenced with survey administration over the phone. This consisted of the interviewer reading each question along with the corresponding response items. The respondent did not have a paper copy available to read, but could ask the interviewer to repeat items as needed. The survey took an average of 19 minutes to complete.

Table 5 presents a list of demographic variables and HBM variables, along with corresponding survey questions. The survey instrument captured each respondent's knowledge, perceptions, and behaviors relating to WNV and their use of arbovirus prevention and control measures, including personal protective behaviors and source reduction behaviors. It also collected the following demographic information: type of dwelling, age, sex, race, ethnicity, geographic area of residence, primary language spoken in household, marital status, employment status, household income level, and education level. In addition, information was collected on the age and sex of participants 60 years of age and over living at the same address in order to indicate the representativeness of those surveyed relative to other household members. Survey responses were recorded on a paper version of the questionnaire and later entered into a secure database.

A list of variables measured, their operational definitions, corresponding survey questions, measurement level, and role in analysis are presented in Table 5 below.

Table 5. Summary of Variables, Operational Definitions, and Survey Questions

Variable	Operational Definition	Survey Question	Measurement Level	Role
Modifying factors: Demographic Characteristics				
Type of Dwelling	Type of housing in which respondent resides	In what type of housing do you live? • Single-family detached home • Townhouse or condominium • Apartment • Active living senior community • Other housing	Nominal	Independent variable (IV)
Age	Self-reported age in years (minimum age must be 60 years old)	Please tell me the age and gender of yourself and others in the household who are ≥ 60 years old.	Ratio	Control
Gender	Self-reported gender (male or female)	Please list your gender Male/Female	Nominal	IV
Race	Self-reported race or ancestry	How would you describe your race? • White or Caucasian • Black or African American • Asian • Native Hawaiian or Other Pacific Islander • Native American/Alaska Native	Nominal	Control
Area of residence	Self-reported geographic area of residence	Is your home located: In a City/In the Suburbs/In a Rural area?	Nominal	IV
Ethnicity	Self-reported as being of Hispanic or non-Hispanic origin	Are you Hispanic or Latino or of Spanish origin? Yes/No	Nominal	IV
Language	Self-reported primary language spoken at home	What is the primary language spoken in your home? English/Spanish/Other	Nominal	IV
Education	Self-reported highest year or level of education completed by respondent	What is the highest level of education you have completed? -Some high school -HS diploma or GED -Some college, include Associates -Bachelor's degree -Some graduate school -Graduate or professional degree	Ordinal	IV

Variable	Operational Definition	Survey Question	Measurement Level	Role
Income	Self-reported annual household income	Which category best describes your total household annual income? ▪ <$20,000 ▪ $20,001-$30,0000 ▪ $30,001-$40,0000 ▪ $40,001-$50,0000 ▪ $50,001-$60,0000 ▪ $60,001-$70,0000 ▪ >$70,000	Interval	IV
Marital status	Self-reported marital status (married, single, divorced, separated, widowed, domestic partnership)	What is your marital status? ▪ Single ▪ Married ▪ Separated ▪ Divorced ▪ Widowed	Nominal	IV
Employment status	Self-reported employment status	What is your employment status? ▪ Full-time ▪ Part-time ▪ Retired ▪ Unemployed ▪ Other	Nominal	IV
Modifying factors: Knowledge of West Nile Virus				
Transmission of WNV	Knowledge of the vector that transmits WNV to humans	How do you think people get WNV? • Eating or drinking contaminated food or water • From bug bites • From birds • Contact with sick people	Nominal	Control
Risk groups for severe disease	Knowledge of age groups at greatest risk of severe neurologic disease from WNV	What age group or groups do you think are most likely to get seriously ill with WNV? • Young children • Adolescents 11-18 • Young adults 19-25 • Adults 26-50 • Adults > 50 years old	Ordinal	IV
Independent variables: Health Belief Model constructs				
Perceived susceptibility	Individual's perception of chance that s/he will contract WNV disease	How worried are you that you might get sick with WNV? Not at all /Little/Somewhat/Very How likely do you think it is that you will get WNV in next calendar year? Not/Somewhat/Moderate/ Extremely	Ordinal	IV

Variable	Operational Definition	Survey Question	Measurement Level	Role
Perceived severity	Individual's perception of the seriousness of WNV disease if s/he were to contract it	Do you think WNV can cause serious illness? No/Yes	Nominal	IV
Perceived benefits	Individual's belief in the efficacy of the recommended behavior to reduce the risk of contracting WNV?	Would you be interested in a community program to help adults over 60 years old repair their damaged window screens and dump standing water in their yard? No/Yes Would you be in favor of a mosquito control program No/Yes How much would you be willing to pay for a WNV vaccine?	Nominal	IV
Perceived barriers	Individual's perceived obstacles to engaging in WNV preventive behaviors	Can you tell me why you do not drain water from items on your property that collect water? ▪ Takes too much effort ▪ Do not have anyone to help me ▪ Too dangerous ▪ There is nothing in my yard that collects water ▪ I do not own my home	Nominal	IV
Self-efficacy	Individual's feelings of confidence in his/her ability to protect him/herself from contracting WNV	How confident are you that you can protect yourself and your household members from getting WNV? Not at all confident/Somewhat confident/Very confident	Ordinal	IV
Cues to action	Self-reported prompts that are likely to stimulate the respondent to engage in behaviors that prevent WNV	Do you know anyone who has had WNV? No/Yes Have you ever received information, in any form, about WNV? No/Yes	Nominal	IV
Dependent Variables (DV): Attitudes and Perceptions				
Support for WNV vaccine	Self-reported willingness to accept a human WNV vaccine if one were available	If a vaccine were available that was safe and effective, would you be willing to take it? No/Yes	Nominal	Dependent variable (DV)

Variable	Operational Definition	Survey Question	Measurement Level	Role
Support for mosquito control programs	Self-reported willingness to support mosquito control efforts	Are or would you be in favor of a mosquito control program like that? No/Yes	Nominal	DV
Dependent Variables: Personal Protective Behaviors				
Use of insect repellent in last 90 days	Self-reported frequency of insect repellent use	In the last 90 days, did you always, sometimes, rarely, or never use insect repellent on your skin when you went outdoors? Always/Sometimes/Rarely/ Never	Ordinal	DV
Draining of standing water	Self-reported frequency of draining standing water around the home	Since the start of this past summer (2012), did someone you asked or hired drain water from items around the outside of your home? No/Yes	Nominal	DV
Dressing in long clothing	Self-reported frequency of dressing in long-sleeved and long pants to avoid mosquito bites	When you go outdoors in the summer, do you wear long-sleeved shirts and/or long pants? No/Yes	Nominal	DV
Avoid outdoors during mosquito feeding hours	Self-reported frequency of avoiding outdoors during mosquito feeding hours (dusk & dawn)	When you go outdoors is it usually: At dusk or dawn In the middle of the day	Nominal	DV

As noted above, the survey questionnaire included questions to determine respondents' general awareness and knowledge of WNV and arboviral disease risk, as well as specific HBM constructs, including perceived susceptibility, perceived severity (perceptions of arboviral disease severity), perceived threat, perceived benefits of practicing personal protective behaviors, perceived barriers, cues to action, and self-efficacy (confidence in their ability to follow public health recommendations, such as eliminating potential mosquito breeding sites, etc.).

Other Survey Questions

The survey instrument included several additional questions that were not part of the research hypotheses. These included items assessing respondent's general knowledge about the disease (risk factors, transmission, vector); awareness of mosquito feeding times (dusk and dawn), if they go out during peak mosquito hours, and type of clothing worn outdoors during peak mosquito hours. To assess knowledge of WNV transmission, respondents were asked "*How do you think most people get West Nile virus?*"; to assess knowledge of WNV risk groups, respondents were asked "*What age group do you think is most likely to get seriously ill from West Nile virus?*" In addition, they were asked about specific habits/behaviors to protect their home from mosquitoes. Specifically, they were asked "*How do you keep your home cool in the summer?" (Fans/Air conditioning/Open windows/Other)*; "*If open windows, do all of the windows in your home have screens? (yes/no)"*and *"If yes, Are your screens in good condition, with no holes or tears? (yes/no)."*

In addition to the knowledge questions, survey respondents were also asked about basic demographic information. These questions represented modifying factors other than those included in the hypothesis testing, that may influence individual's beliefs about WNV, and included respondents' marital status, employment status, ethnicity, primary language, and geographic location. Participants were also asked about their attitudes and awareness toward specific WNV prevention measures, such as their opinions about tax support of mosquito control programs and about creation of programs to help older adults drain standing water and repair damaged window screens.

3.6 Data Collection

For those potential enrollees who indicated a willingness to be contacted (either by indicating that on the postcard or by not returning it within two weeks), study personnel attempted to make phone contact. A series of six attempts were made to reach each potential enrollee by phone. These calls took place at varying times of day on multiple days of the week, including evenings and weekends.

A valid attempt at phone contact was counted if any of the following results were obtained:

- A potential enrollee answers the phone and consents to participate; or
- No one is home and either a message is left or no message is left; or
- Someone is home and that person does not speak English, s/he refuses to talk or participate, or requests that study personnel call back at another time.

These criteria were established because it was recognized that not every household would have voicemail or other means to record a message when no one was home. Likewise, prospective enrollees who did not speak English were excluded because no translators were available to be trained as interviewers. Calls that resulted in an individual's refusal to participate in the study were also considered valid enrollment attempts because contact had been made with a member of the household who met study criteria.

When study personnel contacted a potential enrollee, they verbally provided them with information regarding the potential risks and benefits associated with participation in the study, an explanation of the study rationale and study procedures, and a description of measures that would be taken to ensure security and confidentiality of participant information (see Appendix D for Disclosure Statement). Verbal consent was obtained over the phone in lieu of written informed consent, as the research presented no more than minimal risk of harm to subjects and involved no procedures for which written consent was required outside of the research content.

Eight volunteer interviewers from the DHMH Center for Zoonotic and Vector-borne Diseases (CZVBD) and the Emerging Infections Program (EIP) administered the telephone interviews. All interviewers were trained in standardized interviewing techniques by the author, who was a co-Principal Investigator prior to survey administration. Each interviewer was assigned lists of names and phone numbers obtained from the original stratified random sample of 1700 records for survey calls. After obtaining verbal consent, a member of the research study team conducted a telephone interview for all individuals meeting the eligibility criteria. The interview consisted of a standardized telephone-based interview, conducted in English. A script was used for interviewing all subjects and was read at the start of each interview to disclose risks and benefits and to ensure consistency (see phone script in Appendix B). The survey took between 15 and 20 minutes to administer (average=19 minutes). Respondents who completed the survey were offered the option to receive an Information/Disclosure Sheet, detailing the risks and benefits associated with study participation. No incentives were offered for study participation, but general information about WNV was made available by mail or e-mail upon request. These WNV materials were not automatically sent to all study participants because many indicated a preference not to receive such literature.

Response Rate

A total of 1,191 households were called and of those 1,102 were determined to be eligible to participate in the study (89 were ineligible). A total of 211 individuals were enrolled in the study, yielding a response rate of [19] %. Given that survey administration began in October 2012, time limitations due to the approaching holiday season in December 2012 prevented interviewers from calling the entire sample of 1,700 households.

Demographic Data

Table 5 provides a comparison of selected demographic characteristics of participants and non-participants. The original sampling frame contained only the following demographic information: Gender, Name, Street Address, City, State, Zip Code, and County/Jurisdiction. More detailed demographic information was only collected for study participants after enrollment. Results of chi-square analysis on associations between the modifying factors and dependent variables are shown below in Table 6. Enrollment status differed significantly by gender (X^2=23.99, $p<0.001$) and also by geographic area of residence or jurisdiction (X^2=21.18, $p<0.001$).

Table 6. Comparison of Study Participants and Non-participants

Demographic Characteristics*	Participants (n=211)	Non-participants (n=891)	X^2 p-value
Geographic Area of Residence	**n (%)**	**n (%)**	
Anne Arundel	53 (16)	277 (84)	21.18
Baltimore City	42 (15)	232 (85)	
Baltimore County	39 (34)	77 (66)	<0.001
Harford County	28 (19)	118 (81)	
Montgomery County	49 (22)	175 (78)	
Gender†	**n (%)**	**n (%)**	
Male	99 (46.9)	589 (62)	23.99
Female	108 (51)	302 (38)	<0.001

*Pearson's Chi-square test was used for nominal variables.
†Four respondents declined to specify a gender.

The racial breakdown of the study participants was consistent with that of human WNV cases in Maryland and the U.S. Of the 47 human WNV cases in MD in 2012, 81% (n=38) were White and 8.5% (n=4) were Black (DHMH, Final Summary of WNV Results, 2012). This was similar to the racial distribution of the sample: 79% White and 13% Black. Similarly, for human WNV cases reported to the CDC from 1999-2008, the majority of cases for which race was reported were White (Lindsey, Staples, Lehman, & Fischer, 2010). The gender breakdown was also consistent between study participants and Maryland human WNV cases. Among the MD human WNV cases in 2012, 64% were male and 46% female, comparable to those listed for participants in the table above.

3.7 Variables and Measurement

This study examined associations between six HBM variables (perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy), attitudes toward WNV prevention, and practice of specific WNV preventive measures. It also examined the effects of selected demographic variables (gender, education, employment status, and marital status,), two socioeconomic variables (annual household income and education level) and WNV knowledge. Although the effects of these additional variables were not included in the research hypotheses, their relationship to the dependent variables was of value. Items used in the study instrument included Likert-type and Likert scale items as well as binary response questions and open-ended questions.

3.7.1 Independent Variables: Health Belief Model Constructs

Most variables addressing the HBM constructs were measured via Likert-type response items, while others were measured using dichotomous scales (see Table 4).

1. Perceived susceptibility

Two questions measured respondents' perceived susceptibility to WNV (their perception of personal vulnerability to the disease).

The first question asked "*How worried are you that you might get sick with West Nile virus?*" and was measured on a 1 to 4 scale, with 1 = Not at all worried, 2=A little worried, 3=Somewhat worried, 4= Very worried. Higher scores indicated a higher level of perceived susceptibility. For statistical analysis, this variable was dichotomized as Worried/Not worried, with Not worried coded as zero and A little, Somewhat, and Very worried collectively labeled "Worried" and coded as 1. This dichotomized variable was measured on a 0 to 1 scale.

The second question asked "*On a 1 to 5 scale, with 1 being "not at all likely" and 5 being "extremely likely" how likely do you think it is that you will get West Nile virus in the next calendar year?*" Response items were coded as 1=Not at all likely, 2=Not very likely, 3=Moderately likely, 4=Very likely, and 5=Extremely likely. Higher scores indicated a higher level of perceived susceptibility. Because survey administration occurred in late fall/early winter of 2012, that year's summer WNV season had already concluded. Therefore, the next calendar year was used as the timeframe for this question because it was too late for respondents to comment on their likelihood getting the disease during the current year.

2. Perceived severity

The question "*Do you think West Nile virus is a serious disease?"* was used to measure respondents' perceived severity of WNV and contained a binary (No/Yes) response option measured on a 0 to 1 scale where 0= No and 1=Yes. A higher score indicated a higher level of perceived severity.

3. Perceived benefits

Perceived benefits (positive outcomes that an individual associates with performing the recommended behavior) were measured via two questions that attempted to identify benefits that respondents' associated with certain WNV protective behaviors. One question was measured using a binary response option, while the other used a Likert-type scale.

The first question asked "*Would you be interested in a community program to help adults over 60 years old repair their damaged window screens and dump standing water in their yard?* (No=0/Yes=1). This question was part of a skip pattern, and was only answered by those individuals who had previously answered "open windows" to a multiple-choice question asking how they keep their home cool (response options were A/C, fans, open windows, or a combination). As a result, only a small subset of the total number of respondents (n=76) provided answers to the question about their support for a program to help them repair damaged window screens.

A second question asked "*how much would you be willing to pay out of pocket for the (human WNV) vaccine?*" Range: 1=\$0, 2=<\$25, 3=\$25-\$49, 4=\$50-\$74, 5=≥\$75. For purposes of analysis, this variable was dichotomized into two categories with \$50 as the cutpoint, with 0=≥\$50 and 1=\$0-\$49.

4. Perceived barriers

The perceived barriers construct was represented by two survey questions that attempted to capture respondents' perceptions of barriers to two common WNV PPBs: draining of standing water and use of insect repellent, and were based on qualitative responses to survey questions about why respondents did not practice those behaviors. A respondent's perceived barriers (impediments which they believe prevent them from carrying out recommended WNV prevention measures) were measured in the context of specific WNV personal protective behaviors. Respondents were first asked the following questions about whether or not they performed certain WNV protective behaviors: If they responded "no" to those questions, they were provided with a list of possible reasons for not engaging in the behavior and asked to indicate their reasons for not performing the behavior. These response options included a list of common reasons for not performing the behavior along with an open-ended Other category in which respondents could provide their own answer. Although not a part of the dissertation research study, responses to these open-ended questions were examined in an informal qualitative analysis to identify common themes that might account for Maryland residents' lack of engagement in certain PPBs. The themes identified were classified according to respondents' Professed Knowledge, Perceptions of immunity to WNV, Sense of Inevitability (of WNV Disease), and Beliefs about Religion or Fate.

If a respondent answered "no" to the question "*Since the start of this past summer (2012), did you or someone you asked or hired drain water from items around the outside of your home (such as gutters, buckets, flower pots, kiddie pools, bird baths, or discarded tires)?*" s/he was then asked to indicate why or why not using a list of qualitative response items that included "It takes too much effort/I do not have anyone to help me/It is too dangerous/I use products to keep mosquitoes from breeding in my yard/There is nothing that collects water in my yard/I do not own my home/Other." The qualitative responses to this question were assigned to categories of Personal, Environmental, or Financial reason. As the vast majority of responses fell into the Personal reason category, the response categories were collapsed, with binary response options of Personal/Not personal and these were operationalized as one component of perceived barriers. Responses to this question were included as the independent variable in a series of multivariate logistic regression models to examine hypotheses that test the predictive utility of perceived barriers at explaining respondents' practice of PPBs.

Similarly, in a separate question that asked "*In the last 90 days, did you Always, Sometimes, Rarely, or Never use insect repellent on your skin when you went outside*," respondents who answered "rarely" or "never" were asked to indicate why they seldom or never use repellent using the following response items: "I often forget/It feels sticky/It smells bad/It will make me feel sick/It is too expensive/I didn't know it could help/Other." The majority of responses fell into the Other category, which consisted of unique qualitative responses not among the response items listed above. These qualitative responses were assigned to categories of Personal, Environmental, or Financial reason. As the vast majority of responses fell into the Personal reason category, the response categories were collapsed, with binary response options of Personal/Not personal, and were measured on a 0 to 1 scale where 0= Not personal and 1=Personal.

5. *Cues to Action*

Prior research on the cues to action construct of the HBM has suggested that cues can sometimes take the form of external events, such as a friend or acquaintance getting sick or dying from a disease or from a health care provider providing information or intervention about the disease (Mattson, 1999; Michel et al., 2010). Accordingly, in this survey, cues to action (triggers that activate a person's readiness to take action and engage in WNV protective behaviors) were measured using two questions that illustrated such events.

The first was "*Do you know anyone who has had West Nile virus*?" and included a Yes/No response option (No=0, Yes=1). This item was categorized as a cue to action because awareness of other individuals infected with WNV disease could prompt respondents to learn more about WNV and start taking precautions for themselves. The second question was "*In the last year, have you ever received information in any form about WNV*?" and also used a Yes/No response option (No=0, Yes=1). This question also included a supplemental sub-question for respondents who answered "Yes," asking them to indicate the source of that information; respondents were asked to indicate whether the information came from Doctor/Radio/TV/Newspaper/Internet/E-mail/Mail/Word of Mouth/Other. This variable was measured on a binary scale with No=0 and Yes=1, and these binary response items were applied to each of the different types of information. Possible scores range from 0 to 1.

6. Self-efficacy

A person's self-efficacy (respondent's confidence in his/her ability to take the necessary steps to prevent WNV) was measured via a single Likert-type question. The question was "How confident are you that you can protect yourself and your household members from getting WNV?" and was measured on a three-point scale as 1= Not at all confident, 2=Somewhat confident, and 3= Very confident. This variable was dichotomized as Not confident/Somewhat or Very confident for bivariate analysis, and measured as 0=Not confident, and 1=Confident. A higher score indicated a higher self-efficacy for performing specific WNV PPBs.

Table 7 below shows how each of the six HBM constructs was operationalized for hypothesis testing.

Table 7. Operationalization of Hypotheses

Independent variables: Health Belief Model Constructs				
Construct	**Hypotheses**	**Survey question(s)**	**Variable construction**	**Range**
Perceived susceptibility	Hypotheses 1-6: Individual's perception of worry about and likelihood that s/he will contract WNV disease	How worried are you that you might get sick with WNV? Worried/Not worried How likely do you think it is that you will get WNV in next calendar year? Not likely /Somewhat likely/ Moderately likely/ Extremely	Dichotomized variable (Worry) and 4-point Likert-type scale variable (Likely get WNV)	Range 0-1for dichotomized worry scale; 1-4 for likelihood scale
Perceived severity	Hypotheses 7-12: Perception that WNV serious	Do you think WNV can cause serious illness? No/Yes	Single item (binary)	0 - 1
Perceived benefits	Hypotheses 13-18: Individual's belief in the benefits of engaging in recommended behaviors to reduce the risk of contracting WNV	Would you be interested in a community program to help adults over 60 years old repair their damaged window screens and dump standing water in their yard? No/Yes How much would you pay for a WNV vaccine? $0, <$25, $25-$49, $50-$74, ≥$75	Single items (non-composite)	0 – 1 for each item
Perceived barriers	Hypotheses 19-24: Individual's perceived obstacles to engaging in WNV preventive behaviors	Why you have rarely or never used insect repellent on your skin in the last 90 days? ▪ I often forget ▪ It feels sticky ▪ It smells bad ▪ It will make me sick ▪ It is too expensive ▪ I did not know it helps ▪ Other Why do you not drain water from items on your property that collect water? ▪ Takes too much effort ▪ No one to help me ▪ Too dangerous ▪ Nothing in yard collects water ▪ I do not own my home ▪ Other	Single items (non-composite (barriers to insect repellent use and barriers to draining standing water)	0-1 for each item
Cues to action	Hypotheses 25-30: Self-reported prompts that stimulate PPB	Do you know anyone who has had WNV? No/Yes Have you ever received information, in any form, about WNV? No/Yes	Single items (non-composite)	0 – 1 for each item
Self-efficacy	Hypotheses 31-36: Feelings of confidence in ability to protect self from WNV	How confident are you that you can protect yourself and your household members from getting WNV? Not confident/Confident	Single (non-composite)	0-1

3.7.2 Modifying Factors

The research question for this study asked: Is the Health Belief Model a useful theoretical framework for predicting perceptions and behavior toward West Nile virus prevention among Maryland adults 60 years of age and older? The hypotheses are shown in Table 4. Selected variables, namely sociodemographic variables and knowledge variables, were classified as modifying factors solely according to their definition in the conceptual model which, as described by Glanz (2008), suggests that such factors may have an indirect effect on individual's engagement in a behavior (Glanz et al., 2008). As such, these factors played a key role in answering the research question. These variables were not used, however, as modifiers from a statistical standpoint in analysis. That is, interaction terms were not included in any of the analytic models and models did not examine the effect modification of the above factors on the direct relationship between the HBM constructs and the dependent variables.

3.7.3 Control Variables

Three variables were selected for use as controls during multivariate logistic regression analysis. These variables were age, race, and knowledge of WNV transmission.

Age: Age, at the time of the interview, was recorded in years for each survey participant. All participants were 60 years of age or older. The survey instrument asked each respondent to indicate his/her age in years. Because the sole age of interest was age ≥ 60 years, as specified by the eligibility criteria, age was initially measured as a continuous variable. However, for purposes of comparison during analyses, age was divided into the following categories: 60-69 years old, 70-79 years old, 80-89 years old, and 90-99 years. These categories were then dichotomized as 60-69 years old and 70 years old and above.

***Race*:** This variable was based on self-reported information about racial group affiliation and was measured as a categorical variable. Respondents were asked to identify the racial group with which they most closely identify. The variable response structure was modeled after that of the U.S. Census (ref). Response categories were 1=White or Caucasian, 2=Black or African American, 3=Asian, 4=Native Hawaiian or Other Pacific Islander, 5=American Indian/Alaska Native, 6=Mixed race or Other. For analysis, this variable was dichotomized as White/Non-White.

Knowledge of WNV transmission: Subjects' knowledge of WNV transmission was assessed via the question "*How do you think people get West Nile Virus?*"—response options for this question included both the correct response (from insect bites, such as mosquito bites) and several incorrect responses (Eating or drinking contaminated food or water/From birds/Contact with sick people/Other). These response items were scored as follows: Bug bites=4, Eating or drinking=3, Birds=2, Sick people=1. Those who scored highest (by selecting value 4) were classified as having greater WNV knowledge than those who chose the other selections.

3.7.4 Other Demographic Factors

Gender: Subjects' gender was measured as a dichotomous nominal variable, where 1=male and 2=female.

Education**:** Educational level was measured according to the number of years of education completed by the respondent. The variable consisted of six categories: (1) some high school, (2) high school diploma or GED, (3) some college, (4) Bachelor's degree, (5) some graduate school, and (6) graduate or professional degree. The variable was collapsed into two categories: Less than College and College degree or above. The variable was dichotomized in this manner because the majority of the sample had educational levels that exceed those of the US population: 51% of study respondents hold Bachelor's degrees or higher, compared to only 28.5% of the entire US population, according to the US Census 2008-2012 (Census Bureau).

Annual household income level: Participants' income level was measured as an interval variable with seven categories, each denoting a range of annual household incomes. Response categories were categorized as follows: 1=<$20,000, 2=$20,001-$30,000, 3=$30,001-$40,000, 4=$40,001-$50,000, 5=$50,001-$60,000, 6=$60,001-$70,000, 7=>$70,000. For statistical analysis, the income variable was collapsed into two categories of < $70,000 and ≥ $70,000. This was done because among the study respondents who provided income information, the majority (74%) had income levels below $70,000, while 26% had incomes over $70,000.

Area of residence *(urban/rural/suburban)*: this question asked if the respondent's home was located in the city, suburbs, or a rural area and was measured as a categorical variable. Specifically, it was coded as City=1, Suburbs=2, Rural=3.

Ethnicity *(Hispanic origin*): This variable captured whether the respondent was of Hispanic origin. This was a nominal variable that asked whether the respondent was of

Hispanic or Latino or Spanish origin and had a dichotomous response of No=0 and Yes=1.

Primary language spoken at home: This nominal variable asked what language is spoken in the respondent's household. It was measured on a three-point scale with responses English=1, Spanish=2, and Other = 3.

Marital status: This item asked respondents to indicate their marital status as Single, Married, Divorced, Separated, Widowed, or in a Domestic Partnership. Scores on this item ranged from 1 to 6, where 1=Single, 2=Married, 3=Divorced, 4=Separated, 5=Widowed, and 6=Domestic partnership.

3.7.5 Knowledge

Although knowledge is not a component of the original HBM, the model proposed by Champion and Skinner in Glanz, included it as a modifying factor along with several sociodemographic factors (Glanz, 2008). See Figure 4 for a schematic of the HBM as it is applied to WNV prevention. For this study, survey items that assessed respondents' knowledge of WNV disease were felt to be useful for providing additional context for respondents' beliefs and behaviors. These knowledge variables were included in statistical analysis as confounding variables.

For the survey question below, interviewers were instructed to read all response items and to indicate to the respondent whether to select one item or more response options, depending on the question.

In addition to the knowledge question that was used as a control variable above, the survey also included another knowledge question that sought to capture respondents' understanding of WNV risk groups, but was not included as a control in statistical analysis. Respondents were asked the following question:

"*What age groups do you think are most likely to get seriously ill from West Nile Virus?*" Response options for this question included Young children (0-10 years old)/Adolescents and teenagers (11-18 years old)/Young adults (18-25 years old)/Adults (26-50 years old)/Adults over 50 years old. Responses were Young children=1, Adolescents and teens=2, Young adults (18-25 yo)=3, Adults (26-50 years old)=4, Adults over 50 years old=5, and Combination/more than one group=6. Only the next-to-last response (adults > 50 years old) was correct, however respondents were instructed that they could provide more than one answer and in some instances they responded with two or more age groups, and sometimes included the correct response along with additional age group selections.

A respondent's knowledge level was determined based on whether s/he could correctly name the type of vector that transmits WNV (insect or bug) in the transmission knowledge question above and could correctly identify the single age group at highest risk of severe WNV disease (adults over 50 years old) in this question.

3.7.6 Dependent Variables

Six dependent variables were used as outcomes for testing of the research hypotheses. These variables were:

1. ***Avoiding the outdoors during mosquito feeding hours (dusk and dawn)***

   Respondents were asked "When you go outdoors is it usually: At dusk or dawn;

In the middle of the day? The question had a binary response item of Dusk or dawn=1 or Middle of day=2. It was analyzed using a series of multivariate logistic regression models to test all six HBM constructs to determine if any were significantly associated with avoiding the outdoors at dusk and dawn.

2. ***Dressing in long clothing (long-sleeved shirts and long pants) to avoid mosquito bites***

   Respondents were asked "When you go outdoors during the summer, do you wear long-sleeved shirts and/or long pants?" The question had a binary response item of No=0 or Yes=1. It was examined in a series of logistic regression models that tested the six HBM constructs against each of the six outcomes to determine if any were significantly associated with dressing in protective clothing when outdoors in the summer.

3. ***Use of insect repellent in last 90 days***

   Participants were asked "In the last 90 days, did you always, sometimes, rarely, or never use insect repellent on your skin when you went outside?"

   This was originally a Likert-type question with response categories of Never=1, Rarely=2, Sometimes=3, and Always=4. It was dichotomized as used repellent: 0=No (never or rarely used repellent) and 1=Yes (sometimes or always used repellent). A series of multivariate logistic regression models were constructed to test this outcome against each of the six HBM constructs.

4. ***Draining of standing water***

   Respondents were asked "In the last year (2012), did you or someone you asked or hired drain standing water from objects around your home (such as gutters, buckets, kiddie pools, bird baths, or discarded tires)?"

This question had a binary response item of No=0 or Yes=1. A series of logistic regression models were used to examine the association between this dichotomous variable and the six HBM constructs to determine if any were significantly associated with draining standing water. This outcome was not applicable to all households in the sample, particularly for those respondents who lived in apartment complexes. However, the majority of respondents resided in single family homes.

5. ***Willingness to accept a WNV human vaccine, if one was available***.

   This was a dichotomous response question with a Yes/No response option where No=0, Yes=1. This variable was included in a series of logistic regression models for testing each of the six HBM constructs determine if they were significantly associated with acceptance of a WNV vaccine. Potential confounding factors such as race and WNV knowledge were added to the model along with control variables.

6. ***Support for community mosquito control programs***

   Respondents were asked if they would be in favor of a government mosquito control program that used pesticides to reduce mosquitoes in their community This question had a binary response option of No=0, Yes=1. A series of logistic regression models were used to test each of the six HBM constructs to determine if any were significantly associated with support for mosquito control programs.

3.8 Data Analysis Plan

All statistical tests were performed using STATA v. 12.1 with a level of significance of alpha =.05, unless otherwise noted. All variables were examined for normality to ensure appropriateness of the statistical test selections.

Descriptive Analysis

Descriptive analyses were performed to describe demographic characteristics of the sample and to examine the frequency of self-reported protective behaviors and attitudes toward WNV. This included calculation of means, range, medians and standard deviations for age, the only continuous variable. For nominal and ordinal variables, frequencies and percentages were calculated to describe the sample.

Bivariate Analysis

Selected bivariate analyses were used according to the type of variables being analyzed.

For categorical variables with two or more levels, chi-square tests were used to examine differences between modifiers, independent variables, and dependent variables. Specifically, Pearson's chi-square tests examined associations between demographic variables, including gender (male/female), race, education, annual household income, employment status, and marital status, and the following dependent variables: avoiding the outdoors during mosquito feeding hours, dressing in long-sleeved shirts and long pants, having used insect repellent in the last 90 days, draining items containing standing water, willingness to accept a WNV vaccine, and support for mosquito control programs. Chi-square tests were also used to examine associations between the above six outcomes and the six HBM constructs. Respondent age, race, and WNV transmission knowledge were selected as control variables in multivariate analysis, according to their significance in bivariate analysis.

Spearman's rank correlations were performed via correlation matrix to identify any issues of multicollinearity and to determine the strength of relationships between the independent variables prior to multiple logistic regression analysis. This helped ensure that none of the predictors were too highly correlated with one another, which may have skewed regression results in the multivariate analysis.

Regression Analysis

Multivariate logistic regression analysis was used to examine associations between the HBM constructs, demographic modifying factors, and the six dependent variables. Specifically, logistic regression analysis was performed to test associations between each of the six Health Belief Model constructs and the six outcomes: (1) avoidance of outdoors at dusk and dawn, (2) dressing in long-sleeved shirts and long pants, (3) having used insect repellent in the last 90 days, (4) draining standing water from around the property, (5) willingness to accept a WNV vaccine, and (6) support for mosquito control programs. Stepwise regression model entry techniques were applied and specified a threshold of $p<0.20$ to determine which variables from the bivariate analysis were entered into each multivariate logistic regression model. This model building process involved application of a forward selection procedure followed by backward elimination to ensure consistency among results. Control variables, demographic and knowledge variables, and HBM variables meeting that minimum p-value criterion were entered into logistic regression models to determine their association with dichotomous outcomes pertaining to individual attitudes toward WNV prevention and protective behaviors.

For all six dependent variables, the utility of the HBM constructs of perceived severity, perceived susceptibility, benefits, barriers, and self-efficacy in predicting the designated outcomes of practicing or supporting at least one personal protective behavior were examined.

A minimal amount of missing data was identified in the survey records, and a complete case method was used to address missing data. This method, also known as listwise deletion, involves discarding cases for which there is not complete data.

3.9 Testing of Hypotheses

Research Question: Is the Health Belief Model a useful theoretical framework for predicting perceptions and behavior toward West Nile virus prevention among Maryland adults 60 years of age and older?

Hypotheses

The 36 research hypotheses tested in this dissertation study were framed according to four individual personal protective behaviors (PPBs) and two attitude outcomes: willingness to accept a WNV vaccine and support for community mosquito control programs. The rationale for examining each PPB individually rather than as a composite variable was based on the previous WNV research literature, which suggested a benefit to considering such outcomes on an individual basis. While a couple of studies have examined PPBs as a single composite variable (McCarthy et al., 2001; Adams et al., 2003), several others have demonstrated the value of testing each PPB on its own (Herrington, 2003; Wilson et al., 2005; Bitto et al., 2005; Yerby, 2007), which allows researchers to pinpoint specific activities (e.g. draining standing water and insect repellent use) for development of targeted interventions in the future.

Multivariate logistic regression models were used to test the 36 study hypotheses and followed the guidance of Hosmer & Lemeshow (2000). The model building process involved use of forward selection procedures that were repeated via backward elimination to ensure consistency of results for each model. Per Hosmer & Lemeshow, a threshold was set for entry and removal of variables from each model; in this instance the selected threshold was $p<0.20$. Hypotheses 1-6 tested the perceived susceptibility construct as the primary predictor for each of the six outcomes.

1. *Perceived susceptibility to WNV infection is positively associated with all six outcomes (avoidance of the outdoors, dressing in long shirts and pants, use of insect repellent in last 90 days, draining of standing water, acceptance of a WNV vaccine, and support for mosquito control programs).*

   Hypotheses 1-6 were tested using a series of logistic regression models with perceived susceptibility (in the form of two categorical variables) as the independent variable and each of the six binary outcomes as the dependent variables. Three control variables (age, race, and WNV transmission knowledge) and confounders were entered into the regression models according to significance in bivariate analysis and model entry and removal criteria ($p<0.20$).

2. *Perceived severity of WNV infection is positively associated with all six outcomes (avoidance of the outdoors, dressing in long shirts and pants, use of insect repellent in last 90 days, draining of standing water, acceptance of a WNV vaccine, and support for mosquito control programs).*

Hypotheses 7-12 were tested using a series of six multiple logistic regression models with perceived severity (binary variable) as the independent variable and each of the six binary outcomes as the dependent variables. Both forward and backward stepwise selection procedures were applied. The three control variables and selected confounding variables were entered into the model according to their significance in bivariate analysis and according to model entry and removal criteria ($p<0.20$), to examine their effect on the association between perceived severity and the six outcomes.

3. *Perceived barriers to WNV prevention are negatively associated with all six outcomes (avoidance of the outdoors, dressing in long shirts and pants, use of insect repellent in last 90 days, draining of standing water, acceptance of a WNV vaccine, and support for mosquito control programs).*

   Hypotheses 13-18 were tested using a series of logistic regression models with the two perceived barrier variables (both binary) as the independent variables and the six binary outcomes as the dependent variables. An inverse relationship was predicted such that the higher perceived barriers, the lower the frequency of engaging in WNV PPBs. Both forward and backward selection methods were used. The three control variables and selected confounding variables were entered into the model according to their significance in bivariate analysis and model entry and removal criteria ($p<0.20$).

4. *Perceived benefits of practicing PPBs are positively associated with all six outcomes (avoidance of the outdoors, dressing in long shirts and pants, use of insect repellent in last 90 days, draining of standing water, acceptance of a WNV*

vaccine, and support for mosquito control programs).

Hypotheses 19-24 were tested using a series of logistic regression models with forward and backward selection using the two perceived benefits questions as the independent variables (binary variables) and the six binary outcomes as the dependent variables. The three control variables and selected confounders were entered into the model according to their significance in bivariate analysis and model entry and removal criteria ($p<0.20$).

5. *Cues to action are positively associated with all six outcomes (avoidance of the outdoors, dressing in long shirts and pants, use of insect repellent in last 90 days, draining of standing water, acceptance of a WNV vaccine, and support for mosquito control programs).*

   Hypotheses 25-30 were tested using a series of logistic regression models, with the two binary cues to action variables as the independent variables and the six binary outcomes as the dependent variables. The three control variables and selected confounding variables were entered into the models according to their significance in bivariate analysis and model entry and removal criteria ($p<0.20$).

6. *Self-efficacy is positively associated with all six outcomes (avoidance of the outdoors, dressing in long shirts and pants, use of insect repellent in last 90 days, draining of standing water, acceptance of a WNV vaccine, and support for mosquito control programs).*

   Respondents whose responses indicated that they had a high level of confidence in their ability to protect themselves and/or their families from WNV infection were more likely to have used insect repellent in the last 90 days than those with a low level of confidence. Therefore, a higher self-efficacy score was expected to be associated with more frequent insect repellent use. Hypotheses 31-36 were tested using a series of logistic regression models with the dichotomized self-efficacy variable as the independent variable and the six binary outcomes as the dependent variables. The three control variables and selected confounding variables were entered into the model according to their significance in bivariate analysis and model entry and removal criteria ($p<0.20$).

3.10 Data Management

Frequencies were calculated for each variable to identify missing data and any data errors. A codebook was developed that assigned numeric values to categories of all categorical variables. This process minimized the likelihood of errors in data entry. A quality control review was performed in which an epidemiologist who had not been involved in instrument development or survey administration reviewed every fifth record, comparing responses on the paper survey form to those entered in the database.

Security and Confidentiality

All documents containing personal information were kept confidential and secured in a locked file cabinet at the Maryland Department of Health and Mental Hygiene (DHMH). Data from paper survey forms were initially entered into an Excel spreadsheet and subsequently imported into STATA for analysis. STATA v. 12.1 was used for both data storage and data analysis. Data files were password protected.

Human Subject Research Approval

The parent study was approved by the Institutional Review Board of the Maryland Department of Health and Mental Hygiene in September 2012. This dissertation study was approved by the University of Maryland Institutional Review Board on February 28, 2014. The approval letter is shown in Appendix E.

CHAPTER 4: RESULTS

4.1 Introduction

The purpose of this study was to examine the utility of the HBM for predicting WNV personal protective behaviors (PPBs) among a sample of adults 60 years of age and older in Maryland. This chapter presents results of statistical analyses that described the 211 enrollees and tested hypotheses about associations between the HBM constructs and WNV personal protective behaviors. Univariate analyses were performed to describe the sample and to summarize respondents' outcome behaviors (PPBs), HBM constructs, and WNV knowledge. Bivariate analysis included Spearman's rank correlations and chi-square tests, and were used to examine associations between HBM constructs and demographic variables and between modifying factors and dependent variables. Finally, regression models were used to test the research hypotheses, examining the predictive capacity of each HBM construct to predict the designated outcomes.

4.2 Description of Sample

The study consisted of 211 Maryland residents aged 60 years old and older who completed a survey that captured their knowledge, attitudes, and practices regarding WNV. All participants lived independently and were sampled from zip codes with two or more probable or confirmed WNV cases in the previous five years.

4.2.1 Demographic Characteristics

Table 8 below lists the frequencies and percentages for various demographic characteristics of the study sample. The sample consisted of nearly equivalent numbers of males (49%) and females (51%) and respondents ranged in age from 60 to 99 years old (mean age 70 years; SD=8.22), with a little more than half (55%) falling between 60 and 69 years old. The majority of participants were White (79%) and almost exclusively of non-Hispanic White origin (98%). Respondents primarily speak English at home (98%). Nearly 20% of respondents hold a Bachelor's degree and 32% have a graduate or professional degree. The majority of participants were either married or in a domestic partnership (57%). Most respondents were also retired (72%) and just under half reported an annual household income less than $70,000 (48%), while 26% reported incomes over $70,000.

Table 8. Demographic Characteristics

Demographic Variable		Frequency	Percentage
Gender	Male	99	46.9
	Female	108	51.2
	Refused	4	1.9
Age	(Mean 70 years; SD=8.22; Median 69; Range: 60-99)		
	60 – 69 years	112	53.1
	70 – 79 years	60	28.4
	80 – 89 years	25	11.8
	90 – 99 years	6	2.8
	Refused	8	3.8
Race	White	167	79.1
	Black	28	13.3
	Asian	3	1.4
	Pacific Islander	1	0.5
	Mixed race	4	1.9
	Refused	8	3.8
Hispanic ethnicity	Yes	1	0.5
	No	205	97.6
	Refused	4	1.9
Primary language	English	207	98.1
	Other: Filipino	3	1.4
	Refused	1	0.5
Education	Some high school	8	3.8
	High school/GED	41	19.4
	Some college	46	21.8
	Bachelor's	41	19.4
	Some graduate school	1	0.5
	Graduate or Professional	67	31.7
	Refused	7	3.3
Marital status	Single	20	9.5
	Married	119	56.4
	Separated	1	0.5
	Divorced	17	8.1
	Widowed	44	20.9

Demographic Variable		Frequency	Percentage
	Domestic partnership	1	0.4
	Refused	9	4.2
Employment status	Full-time	28	13.3
	Part-time	19	9
	Retired	151	71.5
	Unemployed	6	2.8
	Other: Disabled	2	1
	Refused	5	2.4
Annual household income			
	≤$20,000	13	6.2
	$20,001-$30,000	21	9.9
	$30,001-$40,000	18	8.5
	$40,001-$50,000	17	8.1
	$50,001-$60,000	18	8.5
	$60,001-$70,000	16	7.6
	>$70,000	55	26.1
Home Ownership			
	Yes	196	92.9
	No	12	5.7
	Refused	3	1.4
Time in residence		Mean: 28.8 SD: 15.06	Range: 2 - 75
Home Region	City	55	26.1
	Suburbs	145	68.7
	Rural	11	5.2
Housing Type	Single family home	174	82.5
	Townhouse or condo	30	14.2
	Senior community	2	1.0
	Other	5	2.3
Zip codes	20902	27	12.8
	20910	22	10.4
	21014	28	13.3
	21060	21	9.9
	21122	35	16.6
	21212	22	10.4
	21214	8	3.8
	21215	17	8.1
	21224	4	1.9
	21222	12	5.7
	21228	15	7.1

Most respondents own their home (93%) and have lived at their current residence an average of 28 years (SD=15.06; range 2 - 75 years). The majority reside in a suburban (69%) or urban area (26%) and live in single family homes (83%) that they own (93%). Respondents are distributed across the 11 study zip codes, with a range of residents per zip code of 4 to 35. The highest percentage of study participants (17%) live in the 21122 zip code (Anne Arundel County). The lowest percentage of participants hailed from the 21224 zip code (Baltimore City).

4.2.2 Behavioral Outcomes

Frequencies and percentages of engaging in WNV PPBs are shown in Table 9. Just over half of all respondents (51%) reported avoiding the outdoors during prime mosquito feeding hours of dusk and dawn, and 56% dress in long-sleeved shirts and long pants when outdoors. The majority of respondents (52%) indicated that, in the previous 90 days, they never used insect repellent on their skin when outdoors, while only 28% always or sometimes used it. Sixty-two % of participants routinely drain standing water from objects around their homes.

Table 9. Personal Protective Behavior Outcomes

Personal Protective Behavior		(Frequency) % of respondents
Avoid going outdoors at dusk and dawn	Yes	(105) 51.2
	No	(100) 48.8
Dress in long-sleeved shirts & long pants	Yes	(115) 55.6
	No	(92) 44.4
Use insect repellent in last 90 days	Always	(9) 4.3
	Sometimes	(51) 24.3
	Rarely	(40) 19
	Never	(110) 52.4
Drain standing water from items around home	Yes	(129) 62.3
	No	(77) 37.2

Study participants' attitudes toward WNV prevention efforts are presented in Table 10. These attitudes include willingness to accept a WNV vaccine, acceptance of a community mosquito control program, and being in favor of tax support for mosquito control activities.

Most respondents (~70%) indicated willingness to accept a WNV vaccine if one was available, and a majority (56%) would not pay more than $25 for it. In addition, 84% of participants expressed support for community mosquito control programs. Among those who stated they would be in favor of mosquito control programs, 86% favored using tax revenues to fund these programs.

Table 10. Attitudes Toward WNV Prevention Programs and Services

Attitude		(Frequency) % of respondents
Willingness to accept WNV vaccine	Yes	(146) 69.5
	No	(26) 12.4
	Maybe	(26) 12.4
	DK	(12) 5.7
If yes, amount willing to pay for vaccine	$0	(14) 9.2
	<$25	(72) 47.1
	$25-49	(34) 22.2
	$50-74	(12) 7.8
	$75-99	(6) 3.9
	>=$100	(11) 7.2
	DK	(4) 2.6
In favor of mosquito control program	Yes	(175) 83.7
	No	(14) 6.7
	DK	(20) 9.6
Favor tax support of mosquito control programs	Yes	(180) 86.1
	No	(17) 8.1
	DK	(11) 5.3
	Refused	(1) 0.5
In favor of a community program to help adults over 60 years old repair damaged window screens and dump standing water in their yard?	Yes	(41) 19.4
	No	(37) 17.5
	DK	(3) 1.4
	Refused	(130) 61.7

4.2.3 Health Belief Model Constructs

This section presents frequencies and percentages for HBM constructs.

Perceived Susceptibility

Most participants did not consider themselves susceptible to WNV disease, with 34% indicating they were not at all worried , 38% only a little worried about getting sick with WNV, and 84% stating it was not at all likely (53%) or not very likely (31%) they would get WNV disease in the next calendar year.

Perceived Severity

Nearly all study participants (96%) believed WNV can cause serious disease; however, 4% indicated they did not know if it causes serious illness or not.

Perceived benefits

Just over half of all respondents (56%) expressed willingness to pay for a WNV vaccine if it cost $25 or less. The remainder of participants were willing to pay varying higher amounts for a vaccine, with approximately 19% of respondents willing to pay $50 or more. The question about participants' interest in a community program to assist persons over 60 with window repair and draining of standing water was part of a skip pattern: it was asked as a follow-up question after establishing how respondents kept their homes cool in the summer months. As a result, more than half the respondents (61%) did not provide answers to that question; 19% expressed interest in such a program and 18% indicated they would not be interested in such a program.

Perceived barriers

Survey questions designed to operationalize the perceived barriers construct were open-ended and asked respondents why they did not engage in certain WNV PPBs, namely using insect repellent on exposed skin when outdoors and draining standing water from objects around their homes. Qualitative responses to those questions were subsequently divided into the following categories: Personal, Environmental, and Financial. Responses in the Personal reason category included such statements as "I don't go outside much," "I always wear long clothing when outside," and "I don't consider mosquitoes a problem (never bitten)." Responses in the Environmental category included "I am not aware of any mosquitoes in the area" and "There is nothing in my yard that collects water." In general, perceived barriers to practicing recommended PPBs included fear of toxic chemicals from repellents, cost, and a perception that taking steps to reduce mosquitoes, such as using insect repellent and draining standing water, are ineffective. Many respondents (81%) indicated they did not drain standing water on their property because they believed no items on their property collected water (81%).

Cues to Action

The majority of participants (58%) reported having received some form of information about WNV in the past year. Conversely, 89% indicated they did not know anyone who had ever gotten WNV.

Self-efficacy

Respondents expressed confidence in their ability to protect themselves and their household members from WNV, with most stating they were somewhat (52%) or very (25%) confident.

Table 11. Health Belief Model Constructs

Health Belief Model Construct		(Frequency) %
Perceived Susceptibility		
How worried are you that you will get sick with WNV?	Not at all worried A little worried Somewhat worried Very worried Don't know	(70) 33.8 (79) 38.2 (39) 18.8 (16) 7.7 (3) 1.4
How likely is it that you will get WNV in the next calendar year?	Not at all likely Not very likely Moderately likely Very likely Extremely likely	(110) 53.4 (63) 30.6 (25) 12.1 (4) 1.9 (2) 1.0
Perceived severity		
Do you believe WNV is serious disease?	Yes Don't know	(199) 96.1 (8) 3.9
Perceived benefits		
Would you be interested in a community program to help adults over 60 years old repair their damaged window screens and dump standing water in their yard?	Yes No Don't know Refused or N/A	(41) 19.4 (37) 17.5 (3) 1.4 (130) 61.7
How much would you be willing to pay for a WNV vaccine?	$0 <$25 $25-49 $50-74 $75-99 >=$100 Don't know	(14) 9.2 (72) 47.1 (34) 22.2 (12) 7.8 (6) 3.9 (11) 7.2 (4) 2.6
Perceived barriers		
If never or rarely used repellent in last 90 days, why not?	Often forget Feels sticky on skin Smells bad Did not know it could help Other Sticky and smells Forget, sticky, and smells Don't know	(5) 3.4 (8) 5.4 (1) 0.7 (1) 0.7 (124) 84.3 (1) 0.7 (1) 0.7 (6) 4.1
If do not drain standing water around home, why not?	Takes too much effort Nothing collects water in yard Other	(1) 1.4 (60) 81.1 (13) 17.5
Cues to Action		
Received information on WNV in the past year	Yes No Don't know	(123) 58.3 (85) 40.3 (3) 1.4
Know anyone who had WNV disease	Yes No Don't know	(22) 10.7 (182) 88.8 (1) 0.5
Self-efficacy		
How confident are you that you can protect yourself and your family from WNV?	Not confident Somewhat confident Very confident Don't know	(30) 14.5 (107) 51.7 (52) 25.1 (18) 8.7

4.2.4 Knowledge

Table 12 describes participants' responses to the two knowledge questions included in the survey instrument.

Table 12. Knowledge of West Nile Virus Risk and Transmission

Knowledge of West Nile Virus	Frequency (%)
How do you think most people get WNV?	
Eating or drinking	3 (1.5)
Insect bites	155 (74.9)
Birds	8 (3.9)
Sick people	6 (2.9)
Other	23 (11.1)
Don't know	12 (5.8)
What age group or groups do you think is/are most likely to get seriously ill from WNV?	
Young children (0-10 yo)	15 (7.4)
Adolescents and teens (11-18 yo)	5 (2.5)
Young adults (19-25 yo)	3 (1.5)
Adults (26-50 yo)	1 (0.5)
Adults >50 yo	50 (24.6)
Young children and adults >50 yo	74 (36.5)
All of the above	25 (12.3)
Don't know	29 (14.3)

Correct responses are italicized.

As shown in the table, most respondents (75%) correctly answered the question on WNV transmission, responding that people get it from insect (mosquito) bites. Among the 11% of respondents who provided other responses not among those listed in the response categories, their responses included germs, poor ventilation, and being in a crowd.

For the question asking which age group or groups are most likely to get seriously ill from WNV, only 25% provided the single correct answer of adults over 50 years of age. An additional 36% indicated both young children and adults over 50 years old are most at risk, while 12 % indicated all of the listed age groups were likely to become seriously ill with WNV infection.

4.2.5 Summary

This section provided a description of the sample and a summary of responses to survey questions. The results indicate the sample was predominantly White and well-educated with middle to high income levels. Participants were aware of WNV and knowledgeable about how it is transmitted and who is at risk. Likewise, perceptions of confidence in ability to avoid WNV infection were also very high in this sample. The next section presents results of bivariate analyses to test associations between the HBM constructs, demographic characteristics, and study outcomes.

4.3 Bivariate Analysis

Bivariate analyses were conducted to examine associations between respondent demographic characteristics, West Nile Virus (WNV) knowledge, and outcome variables as well as between Health Belief Model (HBM) constructs and outcome variables.

Correlation analysis was used to examine associations between independent variables to check for collinearity prior to regression analysis. Spearman's Rank correlation tests were run for the HBM questions that were measured on an ordinal scale (note that many of these variables were collapsed for use in the chi-square tests). The correlation analysis is presented in Table 13 below. None of the variables were highly correlated with one another, indicating that multicollinearity would not be an issue.

Table 13. Spearman Rank Correlations

	How worried about WNV	Likely get WNV	Think WNV serious	Confident protect	How much willing pay	Barriers to repellent
How worried about WNV	1.0000					
Likely get WNV	0.4201 (0.001)	1.0000				
Think WNV serious	-0.0714 (0.52)	0.0210 (0.85)	1.0000			
Confident protect against WNV	-0.1003 (0.37)	-0.2156 (0.05)	-0.0191 (0.86)	1.0000		
How much willing pay for vaccine	-0.0142 (0.89)	0.0247 (0.82)	0.0105 (0.92)	-0.1266 (0.25)	1.0000	
Barriers to repellent use	0.0699 (0.53)	-0.1952 (0.08)	-0.0910 (0.41)	0.0363 (0.74)	-0.1963 (0.075)	1.0000

For each of the six behavioral outcomes: (1) avoiding the outdoors at dusk and dawn, (2) dressing in long-sleeved shirts and long pants, (3) use of insect repellent in the last 90 days, (4) draining of standing water, (5) willingness to accept a West Nile Virus (WNV) vaccine, and (6) support for community mosquito control programs, two tables of bivariate results are presented. The first table shows Pearson chi-square tests of independence between demographic characteristics, a knowledge variable, and one of the six outcomes. The second table shows Pearson chi-square tests of independence between the HBM constructs and the same outcome. For instances in which a cell count was less than five, Fisher's Exact test results are reported in lieu of a chi-square test statistic. As per the definition of race defined by the US Census Bureau, individuals' responses to the questions asking about race and ethnicity on the survey were based solely on self-identification and have no scientific or anthropological basis.

Avoiding Outdoors at Dusk and Dawn

Table 14 shows chi-square tests of independence for respondent characteristics, knowledge, and avoiding the outdoors during mosquito feeding hours. No statistically significant associations were identified.

Table 14. Demographic Characteristics, Knowledge, and Avoiding the Outdoors at Dusk and Dawn

Characteristic		Yes – % (n)	Chi-square	p
Gender	Male	51.6 (49)	0.004	0.95
	Female	52.0 (52)		
Age	60 – 69 years old	56.5 (61)	1.29	0.26
	≥ 70 years old	48.2 (40)		
Education	Less than Bachelor's	51.1 (45)	0.002	0.97
	Bachelor's or above	51.4 (54)		
Marital status	Single	44.0 (33)	3.03	0.08
	Married or domestic partnership	56.9 (66)		
Race	White	54.0 (87)	1.53	0.22
	Non-white	41.9 (13)		
Annual household income	≤ $70,000	47.4 (46)	0.92	0.34
	> $70,000	55.6 (30)		
Knowledge: How do people get WNV?	Correct response: Mosquito bites	50.7 (76)	0.45	0.50
	Incorrect responses	56.3 (27)		

Table 15 presents the results of chi-square tests of independence on associations between HBM constructs and avoidance of the outdoors during mosquito feeding hours (dusk and dawn). A single component of perceived barriers (barriers to draining standing water) did not achieve significance in its association with avoidance of the outdoors at prime mosquito feeding times (p=0.06). That is, individuals who reported barriers to draining standing water around their home (such as physical inability to perform the task or the belief that no objects on the property collected water) were more likely to avoid the outdoors at dusk and dawn (p=0.06).

Table 15. HBM Constructs and Avoiding the Outdoors at Dusk and Dawn

Construct		Yes: % (n)	Chi-sq	p
Perceived susceptibility How worried are you that you might get WNV?	Worried Not worried	52.3 (67) 51.4 (36)	0.015	0.90
How likely is it that you will get WNV in the next year?	Likely Not likely	44.8 (13) 53.2 (90)	0.70	0.40
Perceived severity: Do you think WNV is a serious illness?*	Yes Don't know	51.3 (98) 71.4 (5)	--	0.45
Perceived benefits Would you be interested in a community program to help repair damaged window screens?	Yes No	52.6 (20) 55.8 (19)	0.08	0.78
How much would you be willing to pay for WNV vaccine?	≤ $49 $50 or above	52.2 (59) 63.3 (19)	1.18	0.28
Perceived barriers Why have you not used insect repellent in last 90 days?	Personal Non-personal	53.1 (51) 51.9 (14)	0.014	0.91
Why have you not drained standing water from objects around your home?	Personal Non-personal	50.9 (29) 83.3 (10)	--	0.06
Cues to Action: Have you received any WNV information in the last year?	Yes No	53.3 (64) 50.0 (39)	0.21	0.65
Do you know anyone with WNV?	Yes No	68.2 (15) 49.7 (86)	2.67	0.10
Self-efficacy: How confident you can protect yourself from WNV?	Confident Not confident	54.0 (81) 51.9 (14)	0.043	0.84

*None of the participants reported a "No" response to the perceived severity question; thus, the only operational categories were "Yes" and "Don't know".

Dress in Long-Sleeved Shirts and Long Pants

Table 16 presents chi-square test results for demographic characteristics, WNV knowledge, and dressing in long-sleeved shirts and long pants. Race /ethnicity was significantly associated with dressing in protective attire while outdoors to avoid mosquito bites ($p<0.05$). Out of all participating racial groups, whites accounted for the highest proportion of individuals who dress in protective clothing to avoid mosquito bites. Age also showed borderline significance: individuals 60 to 69 years old showed a borderline significant association with dressing in long clothing when outdoors ($p=0.05$).

Table 16. Demographic Characteristics, Knowledge, and Dressing in Long Shirts and Pants

Characteristic		Yes –% (n)	Chi-sq	p
Gender	Male	60.4 (58)	1.41	0.24
	Female	52.0 (52)		
Age	60 – 69 years old	49.5 (53)	3.76	**0.05**
	≥ 70 years old	63.5 (54)		
Education	Less than Bachelor's	47.8 (43)	4.24	**0.04**
	Bachelor's or above	62.5 (65)		
Marital status	Single	61.8 (47)	1.60	0.21
	Married or domestic partnership	52.6 (61)		
Race	White	52.2 (84)	5.64	**0.02**
	Non-white	75.0 (24)		
Annual household income	≤ $70,000	59.2 (58)	0.77	0.38
	> $70,000	51.8 (28)		
Knowledge: How do people get WNV?	Correct response: mosquito bites	55.6 (84)	0.03	0.85
	Incorrect responses	57.1 (28)		

Table 17 presents chi-square independence test results for HBM constructs and the practice of dressing in long-sleeved shirts and long pants to avoid mosquito bites. No statistically significant associations were noted. Even so, a higher proportion of respondents who believed they were not likely to get WNV indicated they routinely dress in long-sleeved shirts and long pants when outdoors.

Table 17. HBM Constructs and Dressing in Long Sleeved Shirts and Pants

Construct		Yes% (n)	Chi-sq	p
Perceived susceptibility How worried are you that you might get WNV?	Worried	54.2 (71)	0.50	0.48
	Not worried	62.1 (41)		
How likely is it that you will get WNV in the next year?	Likely	43.3 (13)	2.30	0.13
	Not likely	58.2 (99)		
Perceived severity: Do you think WNV is a serious illness?*	Yes	55.4 (107)	--	0.47
	Don't know	71.4 (5)		
Perceived benefits: Would you be interested in program to repair damaged window screens?	Yes	52.5 (21)	1.75	0.19
	No	67.6 (23)		
How much would you be willing to pay for WNV vaccine?	≤ $49	53.5 (61)	0.001	0.99
	>$50	53.3 (16)		
Perceived barriers Why have you not used insect repellent in last 90 days?	Personal	52.0 (51)	0.11	0.75
	Non-personal	55.6 (15)		
Why have you not drained standing water from objects around your home?	Personal	51.8 (29)	--	0.24
	Non-personal	71.4 (10)		
Cues to Action Have you received any WNV information in the last year?	Yes	55.8 (67)	0.003	0.95
	No	56.3 (45)		
Do you know anyone with WNV?	Yes	68.2 (15)	1.41	0.24
	No	54.9 (96)		
Self-efficacy: How confident are you that you can protect yourself from WNV?	Confident	55.6 (84)	0.41	0.84
	Not confident	53.6 (15)		

*None of the participants reported a "No" response to the perceived severity question; thus, the only operational categories were "Yes" and "Don't know".

Use of Insect Repellent in the Last 90 Days

Table 18 presents chi-square tests of independence for respondent demographic characteristics, WNV knowledge, and use of insect repellent in the previous 90 days. Both age of respondent and WNV transmission knowledge showed significant associations with use of insect repellent during that time period ($p<0.05$). As with support for mosquito control, individuals 60 to 69 years old were more likely to engage in insect repellent use than individuals 70 years old and older ($p<0.01$). In addition, respondents who correctly identified insect bites as the means by which WNV is spread were more likely to have used insect repellent during the previous 90 days. No other statistically significant associations were noted between respondent characteristics and insect repellent use. The above findings were significant, suggesting a major role for respondent knowledge and age.

Table 18. Demographic Characteristics, Knowledge, and Use of Insect Repellent in the Last 90 Days

Characteristic		**Yes – % (n)**	**Chi-square**	**p**
Gender	Male	51.0 (49)	1.38	0.24
	Female	42.7 (44)		
Age	60 – 69 years old	56.4 (61)	8.40	**0.004**
	≥ 70 years old	35.6 (31)		
Education	Less than Bachelor's	45.1 (41)	0.48	0.49
	Bachelor's or above	50.0 (53)		
Marital status	Single	41.8 (33)	1.86	0.17
	Married or domestic partnership	51.7 (60)		
Race	White	47.6 (78)	0.15	0.69
	Non-white	43.8 (14)		
Annual household income	≤ $70,000	52.0 (51)	0.21	0.65
	> $70,000	48.2 (26)		
Knowledge: How do people get WNV?	Correct response: mosquito bites	53.3 (81)	7.35	**0.007**
	Incorrect responses	31.4 (16)		

Table 19 shows results of chi-square tests of independence for HBM constructs and use of insect repellent in the previous 90 days. Individuals who expressed worry about getting sick with WNV demonstrated a statistically significant association with insect repellent use during that time period. Specifically, persons who reported being a little worried about WNV infection had the highest proportion of those using repellent. This was a significant association and no other significant associations were found between the remaining HBM constructs and repellent use.

Table 19. HBM Constructs and Use of Insect Repellent in the Last 90 Days

Construct		**Yes: % (n)**	**Chi-sq**	**p**
Perceived susceptibility How worried are you that you might get WNV?	Worried Not worried	57.3 (75) 31.9 (22)	13.27	**<0.001**
How likely is it that you will get WNV in the next year?	Likely Not likely	54.8 (17) 46.5 (80)	0.73	0.39
Perceived severity: Do you think WNV is a serious illness?*	Yes Don't know	49.0 (96) 14.3 (1)	--	0.12
Perceived benefits: Would you be interested in a program to repair damaged screens?	Yes No	51.2 (21) 51.4 (18)	0.0003	0.99
How much would you be willing to pay for WNV vaccine?	≤ $49 $50 or above	51.7 (60) 65.4 (17)	0.23	0.63
Perceived barriers: Why have you not used insect repellent in last 90 days?	Personal Non-personal	25.7 (26) 18.5 (5)	0.61	0.44
Why have you not drained standing water around your home?	Personal Non-personal	40.7 (24) 14.3 (2)	--	0.06
Cues to Action: Have you received any information about WNV in the last year?	Yes No	46.7 (57) 49.4 (40)	0.14	0.71
Do you know anyone with WNV?	Yes No	36.4 (8) 49.4 (88)	1.34	0.25
Self-efficacy: How confident are you that you can protect yourself from WNV?	Confident Not confident	51.6 (79) 48.3 (14)	0.11	0.74

*None of the participants reported a "No" response to the perceived severity question; thus, the only operational categories were "Yes" and "Don't know".

Draining Standing Water

Table 20 shows results of chi-square tests of independence for respondent characteristics and draining standing water on property. Age and transmission knowledge were significantly linked with the practice of draining standing water from items around one's property. Specifically, persons aged 60 to 69 years old were significantly more likely to drain standing water from objects around their home than persons aged 70 and over (p<0.001). Likewise, individuals who correctly identified mosquito bites as the mode of WNV transmission were also significantly more likely to drain standing water around their homes (p<0.001) than those who incorrectly identified the mode of WNV transmission.

Table 20. Demographic Characteristics, Knowledge, and Drain Standing Water

Characteristic		**Yes – % (n)**	**Chi-square**	**p**
Gender	Male Female	60.6 (57) 62.8 (64)	0.09	0.76
Age	60 – 69 years old ≥ 70 years old	74.8 (80) 45.8 (39)	16.77	**<0.001**
Education	Less than Bachelor's Bachelor's or above	55.4 (51) 66.7 (68)	2.57	0.11
Marital status	Single Married or domestic partnership	56.9 (45) 63.7 (72)	0.89	0.35
Race	White Non-white	61.1 (99) 58.1 (18)	0.10	0.75
Annual household income	≤ $70,000 > $70,000	61.6 (61) 56.6 (30)	0.36	0.55
Knowledge: How do people get WNV?	Correct response: mosquito bites Incorrect responses	68.9 (104) 40.8 (20)	12.36	**<0.001**

Table 21 shows chi-square test results for HBM constructs and draining standing water around one's property. Perceived susceptibility and perceived severity both yielded statistically significant associations with the practice of draining standing water (p<0.05). Persons who indicated they were worried about getting WNV were significantly more likely to routinely drain water from objects around their homes (p<0.001); those who consider WNV a severe disease were also significantly more likely to drain standing water around their homes than those who did not feel it was a serious illness (p<0.01). No other statistically significant associations were noted between the other demographic characteristics and this outcome.

Table 21. HBM Constructs and Drain Standing Water

Construct		Yes: % (n)	Chi-sq	p
Perceived susceptibility How worried are you that you might get WNV?	Worried Not worried	72.1 (93) 44.9 (31)	15.71	**<0.001**
How likely is it that you will get WNV in the next year?	Likely Not likely	72.4 (21) 60.2 (103)	1.56	0.21
Perceived severity: Do you think WNV is a serious illness?*	Yes Don't know	63.7 (123) 14.3 (1)	--	**0.008**
Perceived benefits Would you be interested in a community program to help repair damaged window screens?	Yes No	82.5 (33) 71.4 (25)	1.31	0.25
How much would you be willing to pay for WNV vaccine?	≤ $49 $50 or above	59.0 (69) 72.4 (21)	1.77	0.18
Perceived barriers: Why have you not used insect repellent in last 90 days?	Personal Non-personal	58.6 (58) 48.2 (13)	0.94	0.33
Why have you not drained standing water from objects around your home?	Personal Non-personal	3.5 (2) 7.1 (1)	--	0.55
Cues to Action: Have you received any information about WNV in the last year?	Yes No	66.7 (80) 55.0 (44)	2.77	0.096
Do you know anyone with WNV?	Yes No	68.2 (15) 61.7 (108)	0.35	0.56
Self-efficacy: How confident you can protect yourself WNV?	Confident Not confident	68.8 (104) 58.6 (17)	1.16	0.28

*None of the participants reported a "No" response to the perceived severity question; thus, the only operational categories were "Yes" and "Don't know".

Willingness to Accept A WNV Vaccine

Table 22 shows associations between selected demographic characteristics, WNV knowledge, and willingness to accept a WNV vaccine. Only gender and race were significantly associated with respondents' willingness to accept a WNV vaccine, with both having p-values <0.05. Males showed greater vaccine acceptance than females, and whites demonstrated higher vaccine acceptance than non-whites.

Table 22. Demographic Characteristics, Knowledge, and Willingness to Accept a WNV Vaccine

Characteristic		**Yes % (n)**	**Chi-sq**	**p**
Gender	Male	90.5 (76)	5.17	**0.02**
	Female	77.5 (62)		
Age	60 – 69 years old	87.1 (81)	1.71	0.19
	≥ 70 years old	79.4 (54)		
Education	Less than Bachelor's	87.0 (67)	0.83	0.36
	Bachelor's or above	81.8 (72)		
Marital status	Single	78.5 (51)	3.20	0.07
	Married or domestic partnership	88.8 (87)		
Race	White	88.0 (125)	8.77	**0.003**
	Non-White	63.6 (14)		
Annual Household Income	≤ $70,000	84.9 (73)	0.17	0.68
	> $70,000	87.5 (42)		
Knowledge: How do people get WNV?	Correct response: mosquito bites	85.4 (105)	0.38	0.54
	Incorrect responses	81.4 (35)		

Table 23 below presents associations between HBM constructs and willingness to accept a WNV vaccine. Perceived susceptibility was significantly associated with this outcome. Participants who expressed worry about getting WNV were more likely to accept a vaccine than those not worried about getting it. As indicated, none of the other HBM constructs were significantly associated with willingness to accept a WNV vaccine.

Table 23. HBM Constructs and Willingness to Accept a WNV Vaccine

Construct		**Yes: % (n)**	**Chi-sq**	**p**
Perceived susceptibility	Worried	90.0 (99)	7.91	**0.005**
How worried are you that you might get WNV?	Not worried	73.2 (41)		
How likely is it that you will get WNV in the next year?	Likely	83.3 (20)	0.02	0.54
	Not likely	84.5 (120)		
Perceived severity: Do you think WNV is a serious illness?*	Yes	85.2 (138)	3.66	0.11
	Don't know	50.0 (2)		
Perceived benefits: Would you be interested in a program to repair damaged window screens?	Yes	81.8 (27)	0.25	0.61
	No	76.7 (23)		
How much would you be willing to pay for WNV vaccine?	≤ $49	99.1 (111)	--	0.61
	$50 or above	100.0 (29)		
Perceived barriers	Personal	83.5 (66)	--	0.51
Why have you not used repellent in last 90 days?	Non-personal	91.3 (21)		
Why have you not drained standing water from objects around your home?	Personal	81.3 (39)	--	0.73
	Non-personal	76.9 (10)		
Cues to Action: Have you received any information about WNV in the last year?	Yes	81.2 (82)	0.52	0.16
	No	89.2 (58)		
Do you know anyone with WNV?	Yes	82.4 (14)	0.04	0.84
	No	84.3 (123)		
Self-efficacy: How confident you can protect yourself WNV?	Confident	86.2 (106)	0.018	0.90
	Not confident	85.2 (23)		

*None of the participants reported a "No" response to the perceived severity question; thus, the only operational categories were "Yes" and "Don't know".

Support for Community Mosquito Control Programs

Table 24 lists the associations between respondent demographic characteristics, WNV knowledge, and being in favor of a community mosquito control program. None of these associations were statistically significant. Individuals between 60 and 69 years old accounted for the majority of respondents who favored mosquito control programs. A greater proportion of individuals with annual household income levels below $70,000 expressed support for community mosquito control programs than those with higher incomes.

Table 24. Demographic Characteristics, WNV Knowledge, and Support for Mosquito Control Program

Characteristic		**Yes – % (n)**	**Chi-square**	**p**
Gender	Male	93.2 (82)	0.06	0.81
	Female	92.2 (83)		
Age	60 – 69 years old	91.8 (89)	0.02	0.89
	≥ 70 years old and above	92.3 (72)		
Education	Less than Bachelor's	95.2 (80)	--	0.25
	Bachelor's or above	90.3 (84)		
Marital status	Single	90.3 (65)	1.53	0.22
	Married or domestic partnership	95.1 (97)		
Race	White	91.8 (135)	0.08	0.78
	Non-white	93.3 (28)		
Annual household income	≤ $70,000	93.4 (85)	0.0024	0.96
	> $70,000	93.2 (41)		
Knowledge: How do people get WNV?	Correct response: mosquito bites	92.7 (127)	0.12	0.73
	Incorrect responses	91.1 (41)		

Table 25 shows chi-square tests of independence for associations between HBM constructs and support for a mosquito control program. Both perceived severity and a single component of perceived benefits (amount respondent was willing to pay for WNV vaccine), demonstrated statistically significant associations with favoring mosquito control (p<0.05). Individuals who preferred to pay less for a WNV vaccine (<$50) were more likely to support community mosquito control efforts.

Table 25. HBM Constructs and Support for Mosquito Control Program

Construct		Yes: % (n)	Chi-square	p
Perceived susceptibility How worried are you that you might get WNV?	Worried Not worried	94.8 (110) 87.3 (55)	3.21	0.07
How likely is it that you will get WNV in the next year?	Likely Not likely	93.3 (28) 92.1 (140)	--	0.82
Perceived severity: Do you think WNV is a serious illness?*	Yes Don't know	93.1 (163) 71.4 (5)	4.46	**0.035**
Perceived benefits Would you be interested in a community program to help repair damaged window screens?	Yes No	88.9 (32) 96.9 (31)	--	0.21
How much would you be willing to pay for WNV vaccine?	≤ $49 $50 or above	98.1 (104) 84.6 (22)	--	**0.003**
Perceived barriers: Why have you not used insect repellent in last 90 days?	Personal Non-personal	88.6 (78) 96.0 (24)	--	0.27
Why have you not drained standing water from objects around your home?	Personal Non-personal	89.3 (50) 91.7 (11)	--	0.81
Cues to Action: Have you received any information about WNV in the last year?	Yes No	94.5 (104) 88.9 (64)	1.96	0.16
Do you know anyone with WNV?	Yes No	86.4 (19) 93.6 (147)	--	0.22
Self-efficacy: How confident are you that you can protect yourself from WNV?	Confident Not confident	94.9 (130) 88.0 (22)	--	0.19

*None of the participants reported a "No" response to the perceived severity question; thus, the only operational categories were "Yes" and "Don't know".

Summary

The bivariate analyses revealed some significant associations between demographic characteristics, knowledge, and HBM constructs as well as outcome variables. Worry about getting sick with WNV infection was significantly related to multiple behavioral outcomes, including acceptance of WNV vaccine, insect repellent use, and draining of standing water around the home. Only those variables found to be significantly associated with the outcomes in the bivariate analysis will be included as covariates in the multivariate logistic regression models.

4.4 Multivariate Analysis

Multivariate analysis in the form of logistic regression was conducted to test the study hypotheses and to determine which HBM constructs predicted WNV prevention attitudes and behaviors among adults ≥60 years old, after adjusting for confounders. Operationalization and measurement of the independent variables that are used in these analyses are described in the Variables and Measurement section of Chapter 3. Prior to initiating the multivariate logistic regression analyses, bivariate tests were used to determine which control variables should be included in the multivariate logistic regression models. Specifically, Pearson's chi-square tests were used to identify significant associations between respondent characteristics and each of the six dependent variables: (1) avoidance of the outdoors at dusk and dawn, (2) dressing in long-sleeved shirts and long pants when outdoors, (3) having used insect repellent in the last 90 days, (4) draining standing water from around the property, (5) willingness to accept a WNV vaccine, and (6) support for community mosquito control programs.

4.4.1 Summary of Bivariate Analysis Results

Bivariate analyses revealed significant associations between selected HBM constructs and study outcomes. Perceived susceptibility to WNV infection was a significant predictor of insect repellent use (OR=3.04, 95% CI: 1.65-5.59), draining standing water (OR=3.33, 95% CI: 1.82-6.11), and acceptance of a WNV vaccine (OR=3.29, 95% CI: 1.39-7.77). Perceived severity was a significant predictor of draining standing water (OR=10.54, 95% CI: 1.24-89.36). Perceived benefits (OR=9.45, 95% CI: 1.63-54.88) was significantly associated with support for community mosquito control programs.

Although no single demographic characteristic was found to be significantly associated with all six outcomes, three demographic variables demonstrated significant relationships with two or more outcomes in bivariate analysis. Age was found to have a significant association with use of insect repellent ($\chi^2(1)= 8.40$, $p<0.01$; OR=2.34, 95%CI: 1.31-4.19) and draining of standing water ($\chi^2(1)= 16.77$, $p<0.001$; OR=3.49, 95%CI: 1.89-6.43) and a borderline significant association with dressing in long-sleeved shirts and pants when outdoors ($\chi^2(1)= 3.76$, $p=0.05$; OR=0.56; 95%CI: 0.31-1.01). Race was also found to be significantly associated with dressing in long-sleeved shirts and pants when outdoors (χ^2 $(1)= 5.64$, $p<0.05$; OR=0.36, 95% CI: 0.15-0.85) and with acceptance of a WNV vaccine ($\chi^2(1)= 8.77$, $p<0.01$; OR=4.20, 95% CI: 1.54-11.49). Similarly, knowledge of WNV transmission was found to be significantly associated with use of insect repellent ($\chi^2(1)= 7.35$, $p<0.01$; OR=2.49, 95% CI: 1.27-4.89) and draining of standing water ($\chi^2(1)= 12.36$, $p<0.001$; OR=3.21, 95% CI: 1.65-6.24).

4.4.2 Selection of Control Variables for Multivariate Analysis

Based on the results of the above chi-square tests, age, race, and WNV knowledge were selected as control variables to be included in all multiple logistic regression analyses. The results of logistic regression analysis used to test the 36 research hypotheses are presented below and the same three controls were included in all models along with selected independent variables that met specific criteria for model entry, as described below.

4.4.3 Building Logistic Regression Models

For each of the six dichotomous outcomes -- (1) avoidance of outdoors at dusk and dawn, (2) dressing in long-sleeved shirts and long pants, (3) having used insect repellent in the last 90 days, (4) draining standing water from around the property, (5) willingness to accept a WNV vaccine, and (6) support for mosquito control programs – each HBM construct was entered into a logistic regression model, regardless of its significance in bivariate analysis, along with the three control variables and other independent variables that met specific criteria designating a maximum p-value.

Specifically, a logistic regression model was built and variables entered into it using model building techniques described by Hosmer & Lemeshow (2000), which involved identifying statistically significant variables in bivariate analysis, specifying a threshold for entry and removal of variables from the model, and applying stepwise procedures using forward selection with a test for backward elimination (Hosmer & Lemeshow, 2000) to generate a final model. For this analysis, variables with a p-value < 0.20 were used as the threshold for variable removal and entry (Hosmer and Lemeshow specify a cutoff of $p<0.25$, but 0.20 was selected for this analysis instead as a more conservative approach). Accordingly, to test each hypothesis, each of the six outcomes was regressed on each of the six HBM constructs and additional variables that met the $p<0.20$ criterion were also entered into the model. Results are presented below according to the six dependent variables. The tables are grouped accordingly and include all independent variables that were entered into the initial model (regardless of whether they remained in the final model). Only those variables that maintained a significance level of $p<0.20$ were retained in the final model (shaded in each table). Statistical significance was denoted using bold red font.

4.4.4 Results of Multivariate Logistic Regression Analysis

Outcome #1: Avoiding outdoors at mosquito feeding hours of dusk and dawn

Hypotheses 1, 7, 13, 19, 25, and 31 tested the above outcome by regressing the dependent variable on each of the six HBM constructs to determine their effect on respondents' avoidance of the outdoors during mosquito feeding hours of dusk and dawn. The single covariate that met the p<0.20 criteria for entry into the models for this outcome was marital status, which was included in the initial models. Table 26 shows results of the six adjusted logistic regression models to test those six hypotheses.

Table 26. Logistic Regression Models for HBM Constructs and Avoidance of the Outdoors (Hypotheses 1, 7, 13, 19, 25, and 31)*

Independent Variable		Adj OR	p-value	95% CI Lower	95% CI Upper
Hypothesis 1: Individuals with high perceived susceptibility to WNV are more likely to avoid the outdoors at dusk and dawn than those with low perceived susceptibility to WNV.					
Worried about getting WNV	Yes	1.33	0.42	0.66	2.68
	No (reference)	1			
Likelihood of getting sick with WNV	Not at all likely (ref)	1			
	Not very likely	1.59			
	Moderately likely	1.44	0.21	0.77	3.27
	Very likely	1.17	0.48	0.52	4.00
	Extremely likely	0	0.88	0.15	9.44
Marital status	Single/Separated/Div/Widowed	0.68			
	Married (reference)	1	0.23	0.37	1.27
Hypothesis 7: Individuals who believe WNV causes serious illness are more likely to avoid the outdoors at dusk and dawn than those who do not believe it is serious.					
Perceive WNV as a serious illness[†]	Yes	0.21	0.10	0.03	1.32
	Don't know	1			
Marital status	Single/Separated/Div/Widowed				
	Married (reference)	0.60	0.11	0.32	1.12
Hypothesis 13: Individuals who perceive benefits in practicing WNV protective behaviors are more likely to avoid the outdoors at dusk and dawn than those who do not perceive benefits.					
Amount willing pay for WNV vaccine	$0-$49	0.65	0.63	0.11	3.76
	≥ $50 (reference)	1			
Perceived benefits of community program to repair windows	Yes	0.78	0.72	0.19	3.05
	No (reference)	1			
Marital status	Single/Separated/Div/Widowed	1.28	0.73	0.31	5.26
	Married (reference)	1			
Hypothesis 19: Individuals with high perceived barriers to practicing WNV protective behaviors are less likely to avoid the outdoors at dusk and dawn than those with low perceived barriers.					
Perceived barrier to draining standing water	Personal	0.13	0.06	0.02	1.08
	Not Personal (ref)	1			
Perceived barrier to insect repellent use	Personal	3.29	0.15	0.65	16.74
	Not personal (ref)	1			
Marital status	**Single/Sep/Div/Widowed**	**0.13**	**0.01**	**0.02**	**0.66**
	Married (reference)	1			
Hypothesis 25: Individuals who receive cues to action are more likely to avoid the outdoors at dusk and dawn than those who did not receive cues to action.					
Received information about WNV in last year	Yes	1.12	0.73	0.59	2.12
	No (reference)	1			
Know anyone with WNV	Yes	1.75	0.27	0.65	4.71
	No (reference)	1			
Marital status	Single/Separated/Div/Widowed	0.64	0.17	0.35	1.20
	Married (reference)	1			
Hypothesis 31: Individuals with high self-efficacy for preventing WNV infection are more likely to avoid the outdoors at dusk and dawn than those with low self-efficacy for preventing WNV infection.					
Confident can protect self from WNV	Not confident (ref)	1			
	Somewhat confident	0.80	0.63	0.32	1.98
	Very confident	1.32	0.59	0.48	3.67
Marital status	Single/Separated/Div/Widowed	0.68	0.26	0.35	1.33
	Married (reference)	1			

*Age, Race, and WNV knowledge were entered as controls for each of the six hypothesis tests.

[†]None of the survey participants reported a “No” response to the perceived severity question; thus, the only response categories were “Yes” and “Don’t know”.

None of the hypothesized associations between HBM constructs and avoidance of the outdoors at dusk and dawn were supported, but a demographic characteristic was significantly associated with this outcome. Marital status was significantly associated with avoidance of the outdoors in hypothesis 19 with single/unmarried respondents less likely to avoid the outdoors than married respondents (OR=0.11; 95% CI: 0.02-0.63).

Outcome #2: Dressing in long-sleeved shirts and long pants when outdoors

Hypotheses 2, 8, 14, 20, 26, and 32 tested the above outcome by regressing the dependent variable on each of the six HBM constructs to determine their effect on respondents’ choice of attire when outdoors in the summertime. A single covariate, education level, met the $p<0.20$ criteria for entry into the models for this outcome and was included along with the target HBM construct. Table 27 displays results of the adjusted logistic regression models to test those six hypotheses for the above outcome.

Table 27. Logistic Regression Models for HBM Constructs and Dressing in Long-Sleeved Shirts and Long Pants (Hypotheses 2, 8, 14, 20, 26, and 32)*

Independent Variable		Adjusted OR	p-value	95% CI	
				Lower	Upper
Hypothesis 2: Individuals with high perceived susceptibility to WNV are more likely to dress in long-sleeved shirts and long pants than those with low perceived susceptibility to WNV infection.					
Worried about getting WNV	Yes	0.99	0.98	0.48	2.03
	No (ref)	1			
Likelihood of getting sick with WNV	Not likely (ref)	1			
	Not very likely	1.01			
	Moderately likely	2.45	0.99	0.48	2.10
	Very likely	1.43	0.10	0.85	7.04
	Extremely likely	0	0.74	0.17	11.88
Education	**<College degree**	**0.46**	**0.02**	**0.24**	**0.86**
	≥ College degree (ref)	**1**			
Hypothesis 8: Individuals who believe WNV causes serious illness are more likely to dress in long-sleeved shirts and long pants than those who do not believe it causes serious illness.					
Perceive WNV as a serious illness†	Yes	0.87	0.88	0.14	5.40
	Don't know	1			
Education	**< College degree**	**0.46**	**0.01**	**0.25**	**0.85**
	≥ College degree (ref)	**1**			
Hypothesis 14: Individuals who perceive benefits in practicing WNV protective behaviors are more likely to dress in long-sleeved shirts and long pants than those who do not perceive benefits in practicing WNV protective behaviors.					
Amount willing pay for WNV vaccine	$0-$49	1.00	0.99	0.14	7.17
	≥ $50 (reference)	1			
Perceived benefits of community program to repair windows	Yes	0.78	0.74	0.19	3.22
	No (reference)	1			
Education	< College degree	0.71	0.69	0.13	3.82
	≥College degree (ref)	1			
Hypothesis 20: Individuals with high perceived barriers to practicing WNV protective behaviors are less likely to dress in long shirts and pants than those with low perceived barriers to WNV PPBs.					
Perceived barrier to draining standing water	Personal	0.53	0.41	0.12	2.36
	Not Personal (ref)	1			
Perceived barrier to insect repellent use	Personal	1.24	0.77	0.30	5.16
	Not personal (ref)	1			
Education	< College degree	0.31	0.07	0.09	1.10
	≥ College degree (ref)	1			
Hypothesis 26: Individuals who receive cues to action are more likely to dress in long-sleeved shirts and long pants than those who do not receive cues to action.					
Received information about WNV in last year	Yes	0.86	0.65	0.45	1.65
	No (reference)	1			
Know anyone with WNV	Yes	1.93	0.19	0.72	5.20
	No (reference)	1			
Education	<College degree	**0.45**	**0.01**	**0.24**	**0.84**
	≥College degree (ref)	1			
Hypothesis 32: Individuals with high self-efficacy for preventing WNV infection are more likely to dress in long shirts and long pants than those with low self-efficacy for preventing WNV infection.					
Confident can protect self from WNV	Not confident (ref)	1			
	Somewhat confident	0.82	0.66	0.33	2.03
	Very confident	0.58	0.31	0.21	1.66
Education	< College degree	**0.39**	**0.01**	**0.20**	**0.76**
	≥ College degree (ref)	1			

[*]Age, Race, and WNV knowledge were entered as control variables for each of the six hypothesis tests (not shown in table). Race was statistically significant at $p<0.05$ for hypotheses 2, 8, 26. Age was statistically significant at $p<0.05$ for hypothesis 14.
† None of the survey participants reported a “No” response to the perceived severity question; thus, the only response categories were “Yes” and “Don’t know”.

None of the hypothesized associations between each of the HBM constructs and dressing in long shirts and pants were found to be supported. Respondents aged 60-69 years old were significantly more likely to dress in long shirts and pants when outdoors ($p<0.05$) for hypothesis 14. Education was significantly associated with this outcome for hypotheses 26 and 32, with college-educated individuals significantly more likely to dress in long shirts and pants when outside. Race was also a significant predictor of the outcome in hypotheses 2, 8, and 26 ($p<0.05$).

Outcome #3: Having used insect repellent in the last 90 days

Hypotheses 3, 9, 15, 21, 27, and 33 tested the above outcome by regressing the dependent variable on each of the six HBM constructs to determine their effect on respondents’ use of insect repellent on exposed skin in the previous 90 days. Covariates that met the $p<0.20$ criteria for entry into these models were education level and marital status, both of which were included in the initial model along with the target HBM construct. Table 28 shows results of the adjusted logistic regression models to test those six hypotheses for the above outcome.

Table 28. Logistic Regression Models for HBM Constructs and Use of Insect Repellent in the Last 90 Days (Hypotheses 3, 9, 15, 21, 27, 33)*

Independent Variable		Adj OR	p	95% CI	
				Lower	Upper
Hypothesis 3: Individuals with high perceived susceptibility to WNV are more likely to have used insect repellent in the last 90 days than those with low perceived susceptibility to WNV infection					
Worried about getting WNV	**Yes**	**2.30**	**0.02**	**1.12**	**4.73**
	No (ref)	1			
Likelihood of getting sick with WNV	Not likely (ref)	1			
	Not very likely	0.70	0.34	0.33	1.46
	Moderately likely	0.98	0.96	0.35	2.71
	Very likely	0.74	0.78	0.09	6.18
	Extremely likely	0.77	0.87	0.03	17.22
Marital Status	Single/Separated/Div/Widowed	0.73	0.34	0.38	1.40
	Married (reference)	1			
Education	< College degree	0.82	0.54	0.43	1.55
	≥ College degree (ref)	1			
Hypothesis 9: Individuals who believe WNV causes serious illness are more likely to have used insect repellent in the last 90 days than those who do not believe it causes serious illness.					
Perceive WNV as a serious illness†	Yes	3.18	0.32	0.33	30.88
	Don't know	1			
Marital Status	Single/Separated/Divorce/Widowed	0.76	0.39	0.40	1.42
	Married (reference)	1			
Education	< College degree	0.90	0.74	0.49	1.67
	≥ College degree (ref)	1			
Hypothesis 15: Individuals who perceive benefits in practicing WNV protective behaviors are more likely to have used insect repellent in the last 90 days than those who do not perceive benefits in practicing WNV protective behaviors.					
Amount willing pay for WNV vaccine	**$0-$49**	**0.07**	**0.03**	**0.01**	**0.77**
	≥ $50 (reference)	1			
Perceived benefits of program to repair windows	Yes	1.17	0.82	0.30	4.56
	No (reference)	1			
Marital Status	Single/Separated/Divorce/Widowed	0.47	0.31	0.11	2.00
	Married (reference)	1			
Education	< College degree	1.62	0.56	0.32	8.15
	≥ College degree (ref)	1			
Hypothesis 21: Individuals with high perceived barriers to practicing WNV protective behaviors are less likely to have used insect repellent in the last 90 days than those with low perceived barriers.					
Perceived barrier to draining standing water	Personal	1.12	0.93	0.09	14.33
	Not Personal (reference)	1			
Perceived barrier to insect repellent use	Personal	0.81	0.85	0.09	7.54
	Not personal (reference)	1			
Marital Status	Single/Separated/Divorce/Widowed	0.26	0.24	0.03	2.43
	Married (reference)	1			
Education	< College degree	6.95	0.10	0.69	69.85
	≥ College degree (reference)	1			
Hypothesis 27: Individuals who receive cues to action are more likely to have used insect repellent in the last 90 days than those who do not receive cues to action.					
Received information about WNV in last year	Yes	0.63	0.16	0.33	1.20
	No (reference)	1			
Know anyone with WNV	Yes	0.60	0.32	0.22	1.65
	No (reference)	1			
Marital Status	Single/Separated/Div/Widowed	0.68	0.23	0.36	1.29

Independent Variable		Adj OR	p	95% CI	
				Lower	Upper
	Married (reference)	1			
Education	< College degree	0.92	0.80	0.49	1.72
	≥ College degree (reference)	1			
Hypothesis 33: Individuals with high self-efficacy for preventing WNV infection are more likely to have used insect repellent in the last 90 days than those with low self-efficacy for preventing WNV.					
Confident can protect self from WNV	Not confident (reference)	1			
	Somewhat confident	0.86	0.75	0.36	2.08
	Very confident	0.87	0.79	0.32	2.38
Marital Status	Single/Separated/Divorce/Widowed	0.74	0.37	0.38	1.44
	Married (reference)	1			
Education	< College degree	0.89	0.72	0.47	1.69
	≥ College degree (reference)	1			

[*]Age, Race, and WNV knowledge were entered as control variables for each of the six hypothesis tests.
[†] None of the survey participants reported a "No" response to the perceived severity question; thus, the only response categories were "Yes" and "Don't know".

Worry about getting WNV was significantly associated with the use of insect repellent in the previous 90 days, with persons who expressed worry more than twice as likely as those not worried to have used repellent during that time period (OR=2.30, 95% CI: 1.12-4.73). In addition, perceived benefits of paying for a WNV vaccine were significantly associated with insect repellent use, with individuals who preferred to pay less for WNV vaccine having lower odds of having used repellent in the previous 90 days than those willing to pay more (OR=0.07, 95% CI: 0.01-0.77). Age was significantly associated with this outcome for hypotheses 9 and 27, with persons 60 to 69 years old significantly more likely to have used repellent in the previous 90 days than those 70 years old and older.

Outcome #4: Draining of standing water from objects around one's property

Hypotheses 4, 10, 16, 22, 28, and 34 tested the above outcome by regressing the dependent variable on each of the six HBM constructs to determine their effect on respondents' practice of draining standing water on their property. A single covariate met the p<0.20 criteria for entry into these models, education level, which was included in the initial model along with the target HBM construct. Table 29 displays results of the six adjusted logistic regression models for the above outcome.

Table 29. Logistic Regression Models for HBM Constructs and Draining Standing Water (Hypotheses 4, 10, 16, 22, 28, and 34)*

Independent Variable		Adj OR	p	95% CI	
				Lower	Upper
Hypothesis 4: Individuals high perceived susceptibility to WNV are more likely to drain standing water from objects around their homes than those with low perceived susceptibility to WNV					
Worried about getting WNV	**Yes**	**3.06**	**0.01**	**1.42**	**6.58**
	No (ref)	1			
Likelihood of getting sick with WNV	Not at all likely (ref)	1			
	Not very likely	1.08	0.85	0.49	2.40
	Moderately likely	1.21	0.75	0.38	3.83
	Very likely	0			
	Extremely likely	2.19	0.67	0.06	81.76
Education	**< College degree**	**0.49**	**0.04**	**0.25**	**0.97**
	≥ College degree (ref)	1			
Hypothesis 10: Individuals who believe WNV causes serious illness are more likely to drain standing water from objects around their homes than those who do not believe it causes serious illness					
Perceive WNV as a serious illness[†]	Yes	5.17	0.16	0.52	51.76
	Don't know	1			
Education	< College degree	0.59	0.11	0.31	1.13
	≥ College degree (ref)	1			
Hypothesis 16: Individuals who perceive benefits in practicing WNV protective behaviors are more likely to drain standing water from objects around their homes than those who do not perceive benefits in practicing WNV protective behaviors‡					
Perceived benefits of community program to repair windows	**Yes**	**15.97**	**0.04**	**1.09**	**235.11**
	No (reference)	1			
Education	< College degree	0.35	0.36	0.04	3.37
	≥ College degree (ref)	1			
Hypothesis 22: Individuals with high perceived barriers to practicing WNV protective behaviors are less likely to drain standing water from objects around their homes than those with low barriers[Ψ]					
Perceived barrier to insect repellent use	Personal	1.46	0.43	0.57	3.72
	Not personal (ref)	1			
Education	< College degree	0.75	0.49	0.33	1.70
	≥ College degree (ref)	1			
Hypothesis 28: Individuals who receive cues to action are more likely to drain standing water from objects around their homes than those who do not receive cues to action					
Received information about WNV in last year	Yes	1.37	0.36	0.70	2.67
	No (ref)	1			
Know anyone with WNV	Yes	1.30	0.61	0.47	3.58
	No (ref)	1			
Education	< College degree	0.63	0.17	0.33	1.22
	≥ College degree (ref)	1			
Hypothesis 34: Individuals with high self-efficacy for preventing WNV are more likely to drain standing water from objects around their homes than those with low self-efficacy for preventing WNV infection					
Confident can protect self from WNV	Not confident (ref)	1			
	Somewhat confident	0.73	0.52	0.29	1.87
	Very confident	0.69	0.50	0.24	2.00
Education	< College degree	0.59	0.13	0.30	1.17
	≥ College degree (ref)	1			

[*]Age, Race, and WNV knowledge were entered as control variables for each of the six hypothesis tests.
[†]None of the survey participants reported a "No" response to the perceived severity question; thus, the only response categories were "Yes" and "Don't know".

‡Amount willing to pay for WNV vaccine was dropped due to estimability issues.
Ψ Perceived barriers to draining standing water was dropped due to estimability issues.

Of the six hypothesized relationships for this outcome, two constructs, perceived susceptibility and perceived benefits, were found to be significantly associated with draining standing water around one's property. Individuals who expressed worry about getting WNV were significantly more likely to drain standing water from objects around their property (OR=3.06, 95% CI: 1.42-6.58), as were respondents who expressed support for community programs to aid older adults (OR=15.97, 95% CI: 1.09-235.11). Age was significantly associated with the outcome at $p \leq 0.01$ for all six hypotheses. Knowledge of WNV transmission was significantly associated with draining standing water at $p<0.05$ for hypothesis 4, 10, and 28. Education was significantly associated with draining standing water at $p<0.05$ for hypothesis 4.

Outcome #5: Willingness to accept a WNV vaccine

Hypotheses 5, 11, 17, 23, 29, and 35 tested the above outcome by regressing the dependent variable on each of the six HBM constructs to determine their effect on respondents' willingness to accept a WNV vaccine if one were available. Covariates that met the $p<0.20$ criteria for entry into these models were gender and marital status, both of which were included in the initial model along with the target HBM construct. Table 30 lists results of the six adjusted logistic regression models for the above outcome.

Table 30. Logistic Regression Models for HBM Constructs and Willingness to Accept a WNV Vaccine (Hypotheses 5, 11, 17, 23, 29, 35)*

Independent Variable		Adj OR	p-value	95% CI	
				Lower	Upper
Hypothesis 5: Individuals with high perceived susceptibility to WNV are more likely to accept a WNV vaccine than those with low perceived susceptibility to WNV infection					
Worried about getting WNV	Yes	**3.34**	**0.01**	**1.30**	**8.59**
	No (ref)	1			
Likelihood of getting sick with WNV	Not at all likely (ref)	1			
	Not very likely	0.39	0.21	0.90	1.68

Independent Variable		Adj OR	p-value	95% CI	
				Lower	Upper
	Moderately likely Extremely likely	1.18 1.76	0.85 0.73	0.22 0.74	6.21 41.77
Gender	Male Female (ref)	**2.95** 1	**0.03**	**1.08**	**8.02**
Marital Status	Single/Separated/Div/Widowed Married (ref)	0.73 1	0.57	0.24	2.18
Hypothesis 11: Individuals who believe WNV causes serious illness are more likely to accept a WNV vaccine than those who do not believe it causes serious illness					
Perceive WNV as a serious illness†	Yes Don't know (ref)	2.81 1	0.40	0.25	31.91
Gender	Male Female (ref)	2.67 1	0.08	0.89	7.98
Marital Status	Single/Separated/Div/Widowed Married (ref)	0.81 1	0.69	0.29	2.29
Hypothesis 17: Individuals who perceive benefits in practicing WNV protective behaviors are more likely to accept a WNV vaccine than those who do not perceive such benefits‡					
Perceived benefits of program to repair windows	Yes No (ref)	1.33 1	0.73	0.27	6.61
Gender	Male Female (ref)	2.35 1	0.34	0.41	13.39
Marital Status	Single/Separated/Div/Widowed Married (ref)	0.66 1	0.64	0.11	3.90
Hypothesis 23: Individuals with high perceived barriers to practicing WNV protective behaviors are less likely to accept a WNV vaccine than those with low perceived barriers					
Perceived barrier to draining standing water	Personal Not Personal (ref)	0.35 1	0.50	0.02	7.49
Perceived barrier to insect repellent use	Personal Not personal (ref)	3.09 1	0.38	0.25	38.65
Gender	Male Female (ref)	29.98 1	0.06	0.86	1049.5 5
Marital Status	Single/Separated/Div/Widowed Married (ref)	7.29 1	0.30	0.18	301.45
Hypothesis 29: Individuals who receive cues to action are more likely to accept a WNV vaccine than those who do not receive cues to action					
Received information about WNV in last year	Yes No (ref)	0.40 1	0.10	0.13	1.18
Know anyone with WNV	Yes No (ref)	1.13 1	0.89	0.21	6.04
Gender	Male Female (ref)	2.71 1	0.09	0.85	8.68
Marital Status	Single/Separated/Div/Widowed Married (ref)	0.73 1	0.57	0.25	2.16
Hypothesis 35: Individuals with high self-efficacy for preventing WNV infection are more likely to accept a WNV vaccine than those with low self-efficacy for preventing WNV infection					
Confident can protect self from WNV	Not confident (ref) Somewhat confident Very confident	1 0.71 2.31	 0.64 0.26	 0.17 0.54	 3.01 9.97
Gender	Male Female (ref)	1.70 1	0.40	0.49	5.82
Marital Status	Single/Separated/Div/Widowed Married (ref)	0.83 1	0.77	0.25	2.82

*Age, Race, and WNV knowledge were entered as control variables for each of the six hypothesis tests.

[†]None of the survey participants reported a “No” response to the perceived severity question; thus, the only response categories were “Yes” and “Don’t know”.
[‡]Amount willing to pay for vaccine was removed from hypothesis 17 due to estimability issues.

Worry about contracting WNV was significantly associated with acceptance of a WNV vaccine, with individuals who expressed worry being more than three times as likely to accept a WNV vaccine if one were available (OR=3.34, 95% CI: 1.30-8.59). Gender was significantly associated with vaccine acceptance for hypothesis 5, with males nearly three times more likely to accept a WNV vaccine than females (OR=2.95, 95% CI: 1.05-8.02). Race was significantly associated with WNV vaccine acceptance, with Whites more likely than non-Whites to accept a vaccine for hypotheses 11, 29, and 35.

Outcome #6: Support for community mosquito control programs

Hypotheses 6, 12, 18, 24, 30, and 36 tested the above outcome by regressing the dependent variable on each of the six HBM constructs to determine their effect on respondents’ being in favor of a community mosquito control program in their area. None of the demographic covariates met the p<0.20 criteria for entry into these models, and therefore none were included in the initial model along with the target HBM construct. Table 31 shows results of the six adjusted logistic regression models for the above outcome.

Table 31. Logistic Regression Models for HBM Constructs and Support for Community Mosquito Control Programs (Hypotheses 6, 12, 18, 24, 30, 36)*

Independent Variable		Adjusted OR	p-value	95% CI	
				Lower	Upper
Hypothesis 6: Individuals with high perceived susceptibility to WNV are more likely to support community mosquito control programs than those with low perceived susceptibility to WNV					
Worried about getting WNV	Yes	2.44	0.17	0.69	8.70
	No (ref)	1			
Likelihood of getting sick with WNV	Not likely (ref)	1			
	Not very likely	0.74	0.68	0.17	3.17
	Moderately likely	1.34	0.75	0.22	7.96
	Very likely	1			
	Extremely likely	1			
Hypothesis 12: Individuals who believe WNV causes serious illness are more likely to support community mosquito control programs than those who do not believe it causes serious illness					
Perceive WNV as a serious illness†	Yes	8.67	0.06	0.93	80.48
	Don't know (ref)	1			
Hypothesis 18: Individuals who perceive benefits in practicing WNV protective behaviors are more likely to support community mosquito control programs than those who do not perceive benefits in practicing WNV protective behaviors					
Amount willing pay for WNV vaccine	**$0-$49**	**10.60**	**0.01**	**1.68**	**66.77**
	≥ $50 (ref)	1			
Hypothesis 24: Individuals with high perceived barriers to practicing WNV protective behaviors are less likely to support community mosquito control programs than those with low perceived barriers to practicing WNV protective behaviors					
Perceived barrier to draining standing water	Personal	-	-	-	-
	Not Personal (ref)				
Perceived barrier to insect repellent use	Personal	0.27	0.29	0.02	3.02
	Not personal (ref)	1			
Hypothesis 30: Individuals who do receive cues to action are more likely to support community mosquito control programs than those who do not receive cues to action					
Received information about WNV in last year	Yes	2.77	0.09	0.85	9.06
	No (ref)	1			
Know anyone with WNV	Yes	0.52	0.37	0.12	2.19
	No (ref)	1			
Hypothesis 36: Individuals with high self-efficacy for preventing WNV infection are more likely to support community mosquito control programs than those with low self-efficacy for preventing WNV infection					
Confident can protect self from WNV	Not confident (ref)	1			
	Somewhat confident	0.30	0.15	0.06	1.52
	Very confident	0.57	0.52	0.10	3.19

*Age, Race, and WNV knowledge were entered as control variables for each of the six hypothesis tests.
†None of the survey participants reported a "No" response to the perceived severity question; thus, the only response categories were "Yes" and "Don't know".

Willingness to pay $50 or less for a WNV vaccine was significantly associated with support for mosquito control, with individuals who were willing to pay a lesser amount for vaccine 10 times more likely to support a mosquito control program in their community than those who would pay more (OR=10.60, 95% CI: 1.68-66.77). Although this was a significant finding, it was not in the hypothesized direction, as it was expected that persons who were willing to pay more for a vaccine (≥$50) would be significantly more likely to engage in the behavior than those who preferred to pay less. No significant associations were identified between the covariates or control variables and this outcome.

4.4.5 Summary of Findings

Results of this multivariate logistic regression analysis revealed very few HBM constructs were significant predictors of attitudes and personal protective behaviors toward WNV among this sample of Maryland adults ≥ 60 years old. Perceived susceptibility to getting WNV (expressed as worry about getting infected with WNV) emerged as a significant predictor of three outcomes: use of insect repellent, draining of standing water, and acceptance of a WNV vaccine. Perceived benefits (expressed as support for programs to aid older adults in repairing damaged windows and willingness to pay a less than $50 for a WNV vaccine if one were available) were significantly associated with draining standing water and support for community mosquito control programs, respectively. It is possible that the limited predictive capacity of the HBM for WNV prevention outcomes may have been attributable to limited statistical power due to the fact that PPBs were tested individually. If they had been summed together as a composite variable this may have maximized the sample size and associated power. Table 32 provides a tabular summary of findings indicating whether each construct of the Health Belief Model was effective at predicting behavior toward West Nile virus prevention among Maryland adults 60 years of age and older. Results are aggregated for each HBM construct.

These findings may have implications for future research and application of the Health Belief Model to WNV prevention efforts. The strong associations between perceived susceptibility and selected outcomes may prove valuable for health education professionals, by informing risk communication efforts that seek to increase WNV prevention among adults 60 years old and older. In addition, the significance of perceived susceptibility and perceived benefits may suggest new avenues for future exploration of the HBM to study WNV and other vector-borne diseases, as previous studies have often found that other HBM constructs, such as perceived severity and barriers are more likely to predict WNV PPBs. Theory considerations will be discussed along with implications for practice and research in the Discussion chapter.

Table 32. Summary of Hypothesis Test Results, Arranged by HBM Construct

Research Question/Hypotheses	Summary of Findings
Is the Health Belief Model a useful theoretical framework for predicting perceptions and behavior toward West Nile virus prevention among Maryland adults 60 years of age and older?	
Hypotheses 1-6: Perceived susceptibility	**Findings on Perceived susceptibility**
Hypothesis 1: Individuals with high perceived susceptibility to WNV infection are more likely to avoid the outdoors at dusk and dawn than those with low perceived susceptibility to infection.	The hypothesis was not supported. Perceived susceptibility was not significantly associated with avoiding the outdoors.
Hypothesis 2: Individuals with high perceived susceptibility to WNV are more likely to dress in long-sleeved shirts and long pants than those with low perceived susceptibility to infection.	The hypothesis was not supported. Perceived susceptibility was not associated with dressing in long shirts and pants.
Hypothesis 3: Individuals with high perceived susceptibility to WNV are more likely to have used insect repellent in the last 90 days than those with low perceived susceptibility to infection.	**The hypothesis was supported.** People who expressed worry about WNV were significantly more likely to have used repellent.

Hypothesis 4: Individuals with high perceived susceptibility to WNV are more likely to drain standing water from objects around their homes than those with low perceived susceptibility to infection.	**The hypothesis was supported.** People who expressed worry about WNV were significantly more likely to drain standing water.
Hypothesis 5: Individuals with high perceived susceptibility to WNV are more likely to accept a WNV vaccine than those with low perceived susceptibility to infection.	**The hypothesis was supported.** Worry about WNV was significantly associated with vaccine acceptance.
Hypothesis 6: Individuals with high perceived susceptibility to WNV are more likely to support community mosquito control programs than those with low perceived susceptibility to infection.	The hypothesis was not supported. Perceived susceptibility was not associated with mosquito control.

Hypotheses 7-12: Perceived severity	**Findings on Perceived severity**
Hypothesis 7: Individuals who believe WNV causes serious illness are more likely to avoid the outdoors at dusk and dawn than those who do not believe it causes serious illness.	The hypothesis was not supported. Perceived severity was not associated with avoiding the outdoors.
Hypothesis 8: Individuals who believe WNV causes serious illness are more likely to dress in long shirts and long pants than those who do not believe it causes serious illness.	The hypothesis was not supported. Perceived severity not associated with dressing in long clothing.
Hypothesis 9: Individuals who believe WNV causes serious illness more likely to have used insect repellent in the last 90 days than those who do not believe it causes serious illness.	The hypothesis was not supported. Perceived severity not associated with insect repellent use.
Hypothesis 10: Individuals who believe WNV causes serious illness are more likely to drain standing water than those who do not believe it causes serious illness.	The hypothesis was not supported. Perceived severity not associated with draining standing water.
Hypothesis 11: Individuals who believe WNV causes serious illness are more likely to accept a WNV vaccine than those who do not believe it causes serious illness.	The hypothesis was not supported. Perceived severity not associated with vaccine acceptance.
Hypothesis 12: Individuals who believe WNV causes serious illness are more likely to support mosquito control than those who do not believe it causes serious illness.	The hypothesis was not supported. Perceived severity not associated with support for mosquito control.
Hypotheses 13-18: Perceived benefits	**Findings on Perceived benefits**
Hypothesis 13: Individuals who perceive benefits in practicing WNV protective behaviors are more likely to avoid the outdoors at dusk and dawn than those who do not perceive benefits in practicing WNV protective behaviors.	The hypothesis was not supported. No association found between perceived benefits and avoiding the outdoors.
Hypothesis 14: Individuals who perceive benefits in practicing WNV protective behaviors are more likely to dress in long shirts and long pants than those who do not perceive benefits in practicing WNV protective behaviors.	The hypothesis was not supported. No association found between perceived benefits and dressing in long clothing.

Hypothesis 15: Individuals who perceive benefits in practicing WNV protective behaviors are more likely to have used insect repellent in the last 90 days than those who do not perceive benefits in WNV protective behaviors.	**The hypothesis was supported.** Persons preferring to pay less for vaccine were less likely to have used repellent in the last 90 days.
Hypothesis 16: Individuals who perceive benefits in practicing WNV protective behaviors are more likely to drain standing water from objects around their homes than those who do not perceive benefits in practicing WNV protective behaviors.	**The hypothesis was supported.** Persons in favor of aid for screen repair were more likely to drain standing water on their property.
Hypothesis 17: Individuals who perceive benefits in practicing WNV protective behaviors are more likely to accept a vaccine than those who do not perceive benefits.	The hypothesis was not supported. No association found between benefits and vaccine acceptance.
Hypothesis 18: Individuals who perceive benefits in practicing WNV protective behaviors are more likely to support mosquito control programs than those who do not perceive benefits in practicing WNV protective behaviors.	**The hypothesis was supported.** Persons preferring to pay less for vaccine were more likely to support mosquito control.
Hypotheses 19-24: Perceived barriers	**Findings on Perceived barriers**
Hypothesis 19: Individuals with high perceived barriers to practicing WNV protective behaviors are less likely to avoid the outdoors at dusk and dawn than those with low perceived barriers.	The hypothesis was not supported. Perceived barriers to repellent use were not associated with avoiding the outdoors.
Hypothesis 20: Individuals with high perceived barriers to practicing WNV protective behaviors are less likely to dress in long-sleeved shirts and long pants than those with low perceived barriers to practicing WNV PPBs.	The hypothesis was not supported. Perceived barriers were not associated with dressing in long clothing.
Hypothesis 21: Individuals with high perceived barriers to practicing WNV protective behaviors are less likely to have used insect repellent in the last 90 days than those with low perceived barriers to practicing protective behaviors.	The hypothesis was not supported. Perceived barriers were not associated with insect repellent use.
Hypothesis 22: Individuals with high perceived barriers to practicing WNV protective behaviors are less likely to drain standing water than those with low perceived barriers.	The hypothesis was not supported. Perceived barriers not associated with draining standing water.
Hypothesis 23: Individuals with high perceived barriers to practicing WNV protective behaviors less likely to accept a WNV vaccine than those with low perceived barriers.	The hypothesis was not supported. Perceived barriers not associated with vaccine acceptance.
Hypothesis 24: Individuals with high perceived barriers to practicing WNV protective behaviors are less likely to support mosquito control programs than those with high perceived barriers to practicing WNV protective behaviors.	The hypothesis was not supported. Perceived barriers were not associated with support for mosquito control.
Hypotheses 25-30: Cues to action	**Findings on Cues to action**
Hypothesis 25: Individuals who receive cues to action are more likely to avoid the outdoors at dusk and dawn than those who do not receive cues to action.	The hypothesis was not supported. Cues to action were not associated with avoiding the outdoors.

Hypothesis 26: Individuals who receive cues to action are more likely to dress in long-sleeved shirts and long pants than those who do not receive cues to action.	The hypothesis was not supported. Knowing someone with WNV was not significantly associated with dressing in long clothing.
Hypothesis 27: Individuals who receive cues to action are more likely to have used insect repellent in the last 90 days than those who do not receive cues to action.	The hypothesis was not supported. Insect repellent use was not significantly associated with receiving WNV information.
Hypothesis 28: Individuals who receive cues to action are more likely to drain standing water from objects around their homes than those who do not receive cues to action.	The hypothesis was not supported. Cues to action were not associated with draining standing water.
Hypothesis 29: Individuals who receive cues to action are more likely to accept a WNV vaccine than those who do not receive cues to action.	The hypothesis was not supported. Receiving WNV info was not associated vaccine acceptance.
Hypothesis 30: Individuals who do receive cues to action are more likely to support community mosquito control programs than those who do not receive cues to action.	The hypothesis was not supported. Cues to action were not associated with mosquito control support.
Hypotheses 31-36: Self-efficacy	**Findings on Self-efficacy**
Hypothesis 31: Individuals with high self-efficacy for preventing WNV infection are more likely to avoid the outdoors at dusk and dawn than those with low self-efficacy for preventing WNV infection.	The hypothesis was not supported. Self-efficacy was not associated with avoiding the outdoors.
Hypothesis 32: Individuals with high self-efficacy for preventing WNV infection are more likely to dress in long shirts and pants than those with low self-efficacy for preventing WNV infection.	The hypothesis was not supported. Self-efficacy was not associated with dressing in long clothing outdoors.
Hypothesis 33: Individuals with high self-efficacy for preventing WNV infection are more likely to have used insect repellent in the last 90 days than those with low self-efficacy for preventing WNV infection.	The hypothesis was not supported. Self-efficacy was not associated with insect repellent use.
Hypothesis 34: Individuals with high self-efficacy for preventing WNV infection are more likely to drain standing water from objects around their homes than those with low self-efficacy for preventing WNV infection.	The hypothesis was not supported. Self-efficacy was not associated with draining standing water.
Hypothesis 35: Individuals with high self-efficacy for preventing WNV infection are more likely to accept a WNV vaccine than those with low self-efficacy for preventing WNV infection.	The hypothesis was not supported. Self-efficacy was not associated with vaccine acceptance.
Hypothesis 36: Individuals with high self-efficacy for preventing WNV infection are more likely to support community mosquito control programs than those with low self-efficacy for preventing WNV infection.	The hypothesis was not supported. Self-efficacy was not associated with support for mosquito control.

CHAPTER 5: DISCUSSION

5.1 Overview

This chapter presents a summary and discussion of findings resulting from analysis of demographic characteristics, HBM constructs, and study outcomes. It discusses the results of hypothesis tests seeking to examine associations between individual HBM constructs and each of the six designated study outcomes: (1) avoiding the outdoors at dusk and dawn, (2) dressing in long-sleeved shirts and long pants, (3) use of insect repellent in the last 90 days, (4) draining of standing water, (5) willingness to accept a WNV vaccine, and (6) support for community mosquito control programs. These findings are considered within the context of the existing literature on the application of the Health Belief Model to WNV prevention and address implications for theory. The chapter concludes with a description of study limitations, discussion of future research directions, and implications for public health practice.

5.2 Summary of Study and Key Findings

This dissertation involved a secondary analysis of primary data from a cross-sectional study conducted by the Maryland Department of Health and Mental Hygiene (DHMH) in 2012. While the objective of the DHMH study was to identify barriers to WNV prevention among adults ≥ 60 years old in Maryland, this dissertation study examined the utility of all six HBM constructs (perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy) against six WNV behavioral outcomes. The Health Belief Model was selected as the theoretical framework for this study because of its demonstrated utility in explaining individual preventive behaviors associated with diseases. A total of 211 Maryland adults ≥ 60 years old were enrolled in the study. An equal proportion of males and females participated in the survey and respondents ranged in age from 60 to 99 years old, with most between 60 and 69 years of age.

5.2.1 Key Findings

Results of the statistical analysis revealed interesting findings with regard to the survey respondents' WNV knowledge, attitudes, and practices. Most respondents demonstrated high levels of knowledge and awareness of WNV, with 75% correctly identifying that it is transmitted by mosquito bites and 97% stating they believe it causes serious illness. In addition, 70% of respondents reported a willingness to accept a WNV vaccine if one was available, and 83% expressed support for community mosquito control programs in their area. All of these responses suggested an awareness of the disease and receptivity to medical and ecological initiatives to prevent WNV.

Despite respondents' high levels of awareness of the mode of transmission and severity of WNV, most reported little or no concern about getting it. The vast majority (72%) indicated they were not worried or only a little worried about getting infected with WNV and that it would be unlikely they would get it in the next calendar year. Likewise, 76% of respondents expressed confidence that they could readily protect themselves and their household members from WNV infection. To some extent, this confidence and lack of concern about vulnerability to WNV was justified by respondents' reported practice of PPBs. Sixty-two percent reported they regularly drain standing water from objects on their property. Just over half of respondents (51%) reported they avoid going outdoors during prime mosquito hours of dusk dawn and that when they do go outdoors in the summer they dress in protective clothing (long-sleeved shirts and pants) (56%). The single exception to routine practice of PPBs was use of insect repellent: 72% of respondents stated they had rarely or never used insect repellent on exposed skin in the past 90 days. Using insect repellent requires applying a chemical agent on one's skin, which distinguishes it from other WNV PPBs that do not require topical application of a product. Perhaps a reluctance to take such an "invasive" step may be understandable. Still, further scrutiny of some participants' responses to open-ended questions revealed an apparent lack of understanding of exactly how WNV is spread and how mosquitoes breed. For example, in providing reasons why they do not routinely drain standing water on their property, many respondents claimed nothing on their property collects water. Yet, research indicates that as little as a ½ of an inch of standing water can support dozens of mosquito larva, a fact which many residents may not realize, despite health officials' ongoing efforts to include that information in public health messaging (CDC Public Risk brochure, 2004). As noted in the Methods chapter, the timing of survey administration may also have played a role in participants' sometimes incorrect or incongruous responses. Since the survey did not commence until October 2012, just as WNV season was concluding, it is possible that mosquitoes were no longer a concern and that most people had forgotten how often they engaged PPBs, such as using repellent and draining standing water.

Perceived susceptibility refers to an individual's belief that he or she is personally vulnerable to WNV infection and can be expressed in part as a perception of worry or proneness to getting the disease (Janz & Becker, 1984; Murray-Johnson et al., 2006). The HBM proposes that a person engages in a behavior based on cognitive decisions s/he makes about the outcomes of the behavior (Rosenstock, 1974b). That is, the person's decision to take a certain action, such as using insect repellent or dressing in protective clothing, involves a series of linear stages or phases mediated (largely) by the cognitive changes (risk perceptions) described above (Finfgeld, Wongvatunyu, Conn, Grando, & Russell, 2003). Of the six HBM constructs tested in this study, perceived susceptibility emerged as the strongest predictor of engagement in WNV personal protective behaviors (PPBs). In addition, one other HBM construct, perceived benefits, was also significantly associated with selected outcomes in multivariate analysis.

Perceived severity, perceived barriers, cues to action, and self-efficacy all showed no significance with the behavioral outcomes. These findings and their implications are discussed in detail below.

5.3 Hypothesis Testing Results

A set of 36 research hypotheses were used in this dissertation to test the capacity of each of the six HBM constructs to predict six behavioral outcomes. Discussion of these hypothesis test results are grouped according to each HBM construct and are considered within the context of the broader health behavior literature as it applies to WNV and other vector-borne diseases. Results provide insight into our current understanding of what motivates individuals to practice personal protective behaviors to reduce their risk of WNV infection. Findings can inform public health practitioners, enabling them to tailor WNV educational interventions for this high-risk population of adults ≥60 years old based on an understanding of their knowledge, attitudes, and behaviors. Implications for broader environmental health research efforts are addressed as well.

Relationship between Proneness and Practice of WNV PPBs

Hypotheses 1 – 6: Perceived susceptibility

Hypotheses 3, 4, and 5, which tested the perceived susceptibility construct against use of insect repellent, draining of standing water, and willingness to accept a WNV vaccine respectively, were all supported. Perceived susceptibility to WNV emerged as the most important predictor of personal protective behaviors and attitudes towards use of a WNV vaccine. Perceived susceptibility, as measured by the question "How worried are you that you might get sick with WNV," was positively associated with insect repellent use, draining of standing water around one's property, and acceptance of a WNV vaccine if one were available. That is, participants who expressed moderate to high levels of worry about WNV infection were significantly more likely to drain standing water around their property, to have used insect repellent in the previous 90 days, and to accept a WNV vaccine if one were made available. These significant associations were maintained in both bivariate and multivariate analyses. This finding suggests that individual feelings of worry or vulnerability to WNV infection can be a powerful motivator prompting people to engage in important prevention steps such as using repellent and draining standing water.

As described by Conner (2010), the HBM asserts that behavior is determined by two distinct cognitions: (1) the perception of a threat of illness and (2) an evaluation of behaviors to counteract that threat. An individual's threat perceptions are informed by both his/her perceived susceptibility to an illness (likelihood of getting it) and perceived severity to the illness (how serious or deadly it would be for them). Both of these elements form cognitive perceptions or rational judgments about a person's risk of disease. Therefore, use of a survey question in this study asking respondents to quantify their level of worry about getting WNV infection may not have been an appropriate operationalization of perceived susceptibility, as worry represents an emotional affect rather than a cognitive perception (Freimuth & Hovick, 2012). This imprecise measurement of perceived susceptibility represents a key limitation that should be considered in the interpretation of these study results. Cognition refers to the deliberative assessment of a disease event occurring, while affect refers to an individual's emotional feeling or response to such an event, and is often conceptualized as mood, anxiety, or worry (Janssen, Waters, van Osch, Lechner, & de Vries, 2014; Farley & Stasson, 2003). The HBM has long been recognized as part of a class of social-cognition models that apply individual thought processes to an examination of health behaviors, and as such has often been criticized for focusing exclusively on cognitive risk perceptions and ignoring the role of emotional affect (Freimuth & Hovick, 2012; Conner, 2010; Brewer & Rimer, 2008). Despite the noted distinctions between cognition and affect, ambiguity remains and recent research has called for increased attention to the potential overlap between cognitive and emotional components, as well as to gaps in the literature examining the influence of affective attitudes on health decision-making (Janssen et al, 2014; Conner, 2010; Keer, van den Putte, & Neijens, 2010; Lawton, Conner, & McEachan, 2009).

Applications of Worry in Theory-based Communicable Disease Research

Prior research on psychosocial factors associated with Lyme disease (LD) prevention found a similar association between feelings of worry or concern about getting infected and practice of LD preventive behaviors, such as checking the skin for ticks and wearing protective clothing (Beaujean, Bults, van Steenbergen, & Voeten, 2013; Herrington, 2004). Although Lyme disease is a tick-borne disease, like WNV, it is endemic throughout much of the US and it can be prevented through many of the same actions used to prevent WNV, including use of insect repellent on exposed skin and dressing in long-sleeved shirts and long pants (Hayes & Piesman, 2003; Herrington, 2004). Although a Lyme disease vaccine is no longer on the market, at one point it was available, and so studies examining LD vaccine uptake remain salient and make for valid comparisons with the findings in this study regarding WNV vaccine acceptance.

Interestingly, the other survey question designed to assess perceived susceptibility, "how likely do you think it is that you will get WNV in the next calendar year," was not significantly associated with any of the research outcomes. It is unclear why only the worry question was significantly associated with the three outcomes (use of insect repellent, draining standing water, and acceptance of WNV vaccine), particularly given the breakdown of responses to both questions was similar, with a high percentage of respondents (70-80%) indicating they had little or no concerns about getting WNV in the future. This discrepancy could be explained by fear or threat arousal, as worry is often equated with fear and has been demonstrated to produce varying responses among individuals seeking to avoid disease (Bish, Yardley, Nicoll, & Michie, 2011; Nan, 2012). Specifically, worry about getting a disease can result in positive action to prevent the disease, such as taking a vaccine, complying with a medication regimen, or using insect repellent, or it can result in inaction, in which the person feels too frightened to take action and avoids any preventive steps (Senay, Alford, & Kaphingst, 2013).

As described earlier in this chapter, worry represents an affective reaction, along with other emotions like fear and anger, and plays a role in risk judgments about disease or other health conditions (Senay et al, 2013). Specifically, worry is characterized by feelings of anxiety and tension and is associated with concerns about future rather than past events (Mosher et al., 2008). Worry helps shape an individual's overall risk perception and has been examined in research studies on other infectious diseases, which, like WNV, have had documented nationwide outbreaks, including SARS and H1N1 (Liao, Cowling, Lam, Ng, & Fielding, 2014; Reuter & Renner, 2011). Historically, risk perception theorists have asserted that feelings of vulnerability and dread are inversely related to knowledge and experience with hazard avoidance (Reuter & Renner, 2011). That is, persons who feel very vulnerable to a particular disease often have limited knowledge about the disease and/or minimal experience in mitigating their risk.

The finding of perceived susceptibility as a significant predictor of WNV behavior is consistent with the finding by Herrington (2003) that perceived susceptibility was the strongest predictor of actions to avoid mosquito bites among a nationally representative sample of adults ≥18 years old. It is important to note, however, that Herrington also found that study participants' perceived susceptibility to WNV disease was eclipsed by the perceived toxicity of insect repellent. In addition, the finding that perceived susceptibility was the strongest predictor of WNV PPBs was also supported by Adams et al., (2003), who identified a significant association between feelings of worry about WNV infection and practice of PPBs. Just as in the Adams study, people who expressed worry about getting WNV were significantly more likely to accept a WNV vaccine and to engage in protective behaviors. Study findings regarding perceived susceptibility are partially consistent with those of Bitto et al., (2005) who found that both perceived threat and perceived benefits were associated with reduced WNV risk behavior.

Thus, this study provides further support for the assertion that the perceived susceptibility construct is predictive of selected WNV PPBs. This is understandable, as persons who experience strong feelings of worry about getting WNV may feel motivated to take steps to avoid mosquito bites and to receive an approved WNV vaccine if one were made available. Bitto et al. (2005) determined that perceived threat (perceived susceptibility and perceived severity) was predictive of most behavioral outcomes. Although the current study did not expressly test the combined perceived threat construct, it examined perceived susceptibility and perceived severity individually and determined perceived susceptibility was a strong predictor of most WNV PPBs.

Implications of Worry for Future Research and Practice

Worry as an indicator of fear and threat appraisal, has implications for program development. Accordingly, health educators and other public health professionals should consider the important role of worry in development of public messaging. It may be helpful to develop interventions that increase feelings of worry about WNV among this population of high-risk adults. Such interventions could include public health messages highlighting the risk of WNV for older individuals and emphasizing that anyone who lives in areas where mosquitoes are active is vulnerable to WNV infection. Still, care must be taken to ensure messages highlighting the dire health effects of not practicing

PPBs are not so extreme as to trigger panic and excessive fear among the target audience, as this may be paralyzing and undermine their desire to take preventive actions.

Relationship between Perceptions of WNV Severity and PPBs

Hypotheses 7 – 12: Perceived severity

Perceived severity did not significantly predict any of the six WNV protective behaviors. In bivariate analysis, perceived severity was significantly associated with two outcomes: draining standing water and support for community mosquito control ($p<0.05$); however, this significance was lost during multivariate logistic regression analysis. The association between perceived severity and support for mosquito control programs approached significance ($p=0.06$). In fact, persons who believed WNV causes serious illness were nearly nine times more likely to be in favor of community mosquito control efforts, although the association did not achieve statistical significance. Previous studies have found a significant association between perceived severity and WNV PPBs (Adams et al., 2003; Gujral et al., 2007; Butterworth, 2009). It is plausible that individuals who perceive WNV as a serious disease with potentially dire health consequences would support activities that reduce mosquito populations, such as elimination of mosquito breeding sites by draining standing water and community-level efforts at mosquito abatement. Despite the lack of significant association between perceived severity and outcomes in this study, it was encouraging to note that most adults over 60 years old in this study sample recognize the threat of severe illness associated with WNV infection. The lack of a significant association between perceived severity of WNV and PPBs may be due in part to the timing of survey administration. Because the survey was administered in October 2012, just as the WNV season was ending, there was little media coverage of WNV human cases and fatalities in Maryland, which may have lessened the perceived overall impact of the disease.

Relationship between Perceptions of Benefits and PPBs

Hypotheses 13 – 18: Perceived benefits

Like perceived susceptibility, the perceived benefits construct was found to be associated with three of the six outcomes, although not always in the hypothesized direction. Perceived benefits were significantly associated with insect repellent use, draining standing water, and support for community mosquito control. Study participants who preferred to pay a lower amount ($0-$49) for a WNV vaccine were significantly less likely to have used insect repellent in the previous 90 days than those willing to pay a higher price (≥$50) for vaccine. That is, those who would invest less money in a WNV vaccine were also less likely to practice other preventive behaviors. By extension, this suggests that individuals who are willing to invest more in a WNV vaccine, and therefore perceive a benefit in protecting themselves from WNV infection, would be more likely to use insect repellent on their exposed skin when outdoors as a means of personal protection than those not willing to invest as much. This was consistent with hypothesis #15. In addition, persons willing to pay $0- $49 for a WNV vaccine were 10 times more likely than those willing to pay a higher price ($50 or more) to support community mosquito control programs. This contradicted the hypothesized direction of this association, as it was anticipated that a willingness to spend more money on a vaccine would correlate with greater likelihood of supporting mosquito control programs in the community. It appears then, that contrary to expectations, people who may not consider a WNV vaccine worth a significant investment of personal funds would still be more willing to invest in other protective measures at both the individual and community levels. Even so, much of a respondent's behavior may hinge on cost, as a WNV vaccine could easily shift from being a personal benefit to a barrier if the financial cost became too high.

Cost of vaccine (and overall economic impact of vaccine receipt) has also been documented as a barrier in relation to vaccines for seasonal and pandemic H1N1 influenza (Gray et al, 2012; Coe, Gatewood, Moczygemba, Goode, & Beckner, 2012). The significance of perceived benefits for explaining risk prevention behavior has been similarly associated with H1N1 influenza prevention behaviors, with individuals who see a benefit in preventive action more likely to practice social distancing by avoiding crowds to reduce their risk of infection (Durham, Casman, & Albert, 2012). Likewise, perceived benefits were also a significant predictor of adaptive behavior to prevent heat wave illness among a sample of Australian adults, with persons who perceived benefits in taking preventive measures such as reducing physical activity, drinking lots of water, and seeking cool shelter during heat waves more likely to regularly engage in those behaviors (Akompab, Bi, Williams, Grant, Walker, & Augostinos, 2013).

In addition, respondents who supported a community program to assist older adults with repairing damaged window screens to keep mosquitoes out were 16 times more likely to drain standing water from objects around their property than those who did not support such a program, and the association was significant. Those who recognized the usefulness of community initiatives to help older adults at high risk for WNV were likely to demonstrate common patterns of behavior taking responsibility to drain standing water in their own yards.

The lack of statistical significance for the other outcomes (avoidance of the outdoors at dusk and dawn, dressing in long shirts and pants, and acceptance of a WNV vaccine) could suggest some weaknesses in the HBM itself, indicating that perhaps it may not be the most desirable model for predicting WNV PPBs. The applicability of the HBM as a predictive tool for WNV prevention will be discussed in greater detail later in this chapter.

Relationship between Perceptions of Barriers and PPBs

Hypotheses 19 – 24: Perceived barriers

None of the hypotheses that tested perceived barriers against the six outcomes were supported. Individuals who reported barriers to insect repellent use were three times more likely to avoid the outdoors during prime mosquito feeding hours in the summer than those who did not perceive such barriers, but the association was not significant. This is contradictory to the findings of some studies applying the HBM to WNV prevention behavior, which found significant associations between perceived barriers and WNV prevention practices (Aquino et al., 2004; Bitto et al., 2005; Butterworth, 2009). The finding in this study is, however, consistent with that of Yerby (2007), who conducted the first validation of a theory-based WNV knowledge and attitudes survey instrument. Yerby (2007) found perceived barriers to insect repellent use was the only construct that did not predict practice of PPBs. She noted that this finding may have been due to a sense of personal obligation to wear repellent, and to the larger influence of social norms, which many of her focus group participants described during sessions. The influence of others in a community could serve as a powerful social norm, and, in that study, peer pressure from community members may have prompted respondents to regularly use insect repellent and drain standing water on their property, despite their personal objections or barriers to doing so. Indeed, practice of PPBs could be heavily influenced by social norms, including social pressure from community members to eliminate mosquito breeding sites. Additional research is needed to further explore such associations.

Data on respondents' perceived barriers were captured using open-ended survey questions that allowed for a wide range of unique and subjective individual responses. Respondents who stated they did not use insect repellent or did not drain standing water were asked why they routinely did not do so, and responses varied widely. Some respondents stated they simply forgot to apply repellent, others expressed personal discomfort and safety concerns with applying it on their skin, and still others claimed it would make them sick. Herrington (1997) noted the same concerns about insect repellent in his 1997 study of adults' risk perceptions toward ticks and Lyme disease (Herrington, et al., 1997). In addition, in a 2004 study, he determined that despite an established 40-year history of safety and efficacy of repellents, many survey respondents remained skeptical of the effectiveness of insect repellent at preventing tick bites and a small percentage believed it caused illness (Herrington, 2004).

Relationship between Cues to Action and PPBs

Hypotheses 25 – 30: Cues to action

No support was found for cues to action being associated with any of the six outcomes. Neither having received information about WNV in the previous year, nor knowing someone diagnosed with WNV was found to be significantly associated with any of the six outcomes. Persons who had received WNV information in the past year were nearly three times more likely to support community mosquito control than those who had not, but the association was not significant. Likewise, individuals who knew someone with WNV were nearly twice as likely to dress in long-sleeved shirts and long pants, but that association was also not significant. The lack of significant associations between receipt of information about WNV or knowledge of someone infected with the virus and the study outcomes suggests that in this sample, neither exerts a major influence on individuals' actions with respect to WNV prevention. This finding contradicted that of Aquino (2004), who found that having received information about WNV significantly predicted draining of standing water and other PPBs among survey respondents in British Columbia. As discussed in the Literature Review, cues to action remain the least researched and least addressed of all the HBM constructs (Carpenter, 2010; Mattson et al., 1999).

Although either of the above cues might be sufficient to prompt a person to engage in one or more WNV personal protective behaviors, existing literature suggests that such preventive actions are more often driven by perceptions of risk (severity of WNV and personal susceptibility to it). It is possible, however, that not enough information was collected about the context in which respondents received WNV information. That is, there were no follow-up questions to elucidate whether the individual respondent had actively sought out WNV information by searching for it online at a library, or from his/her healthcare provider, rather than simply receiving it in the mail without solicitation.

Little or no association between cues to action and engagement in protective behaviors has been found in other studies examining HBM constructs relative to practice of protective behaviors (Yarborough et al, 2001; Green & Brinn, 2003). Findings of this study supported that pattern.

Relationship between Self-efficacy and PPBs

Hypotheses 31 – 36: Self-efficacy

None of the hypotheses that tested self-efficacy against the six outcomes were supported. Although study respondents expressed high levels of confidence in their ability to protect themselves from WNV infection, that confidence did not translate into active practice of WNV PPBs. The self-efficacy variable was not significantly associated with any of the outcomes, either in bivariate or multivariate analysis. This was in stark contrast to the findings by Bitto et al. (2005), who found that lack of self-efficacy was associated with failure to routinely use insect repellent (Bitto et al., 2005). Yet, other studies also found little or no significant associations between the self-efficacy construct and WNV PPBs (Yerby, 2007), just as in this dissertation. Beaujean et al. (2013) reported low levels of self-efficacy for wearing protective clothing and using insect repellent in their study of Lyme disease perceptions and protective behaviors in a sample of adults in the Netherlands. In that study, low levels of self-efficacy were attributed to lack of knowledge about the effectiveness of insect repellent at preventing tick bites. A similar knowledge deficit may be present in this sample, with some Maryland adults failing to recognize that insect repellent can be effective against mosquitoes.

5.4 Influence of Demographic Characteristics and Knowledge

Age was a significant predictor for several outcomes, with adults 60 to 69 years old significantly more likely to practice certain PPBs, such as dressing in long-sleeved shirts and long pants and draining standing water. This was partly consistent with the finding by Adams et al. (2003) that adults over 50 years old were more likely to practice at least one PPB compared to their younger counterparts (Adams et al., 2003). However the Adams study compared adults 50 years old and above to adults under 50 years old, while this research study looked exclusively at adults 60 years of age and above, only comparing those 60 to 69 with those 70 years old and older. The older adults (those 70 years old and above) in this study tended to be retired and to spend considerable time outdoors (thus increasing their contact with mosquitoes), while adults in the Adams study are likely to still be in the workforce and possibly spending more time indoors.

Other demographic characteristics emerged as having significant associations with outcomes in multivariate analysis. Race was significantly associated with dressing in long-sleeved shirts and long pants and accepting a WNV vaccine, with Whites more likely than non-Whites to practice those behaviors. Education level was significantly associated with dressing in long shirts and pants and draining standing water on one's property, with more educated individuals--those with a Bachelor's degree or higher--more likely to engage in those behaviors. Marital status was significantly associated with avoidance of the outdoors at dusk and dawn, with married respondents more likely to avoid going outdoors at key mosquito feeding hours than their single counterparts.

Gender was significantly associated with willingness to accept a WNV vaccine, with males nearly three times more likely than females to accept a vaccine. These associations were not particularly surprising, since the study sample was primarily White and well-educated, with more than half of respondents having annual household income levels of $70,000 or above. Prior research on Lyme disease has suggested that high levels of education and income often correlate with greater knowledge about disease transmission and increased participation in preventive behaviors, including those that incur a financial burden (Herrington et al., 1997).

5.5 Qualitative Analysis of Risk Perceptions from DHMH Study

In other analyses of the primary dataset used in the DHMH study of barriers to WNV prevention, several qualitative responses to survey questions were examined. Although not a part of this dissertation study, results of this brief qualitative analysis revealed some noteworthy findings relevant to this discussion (unpublished data). The survey questionnaire included several open-ended questions that sought to capture respondents' underlying cognitive beliefs associated with the behaviors and perceptions they reported on the survey. These open-ended questions included questions about perceived barriers to use of insect repellent (n=132) and draining standing water (n=18), as well as about respondents' reasons for expressed worry about getting WNV (n=113), and professed confidence in their ability to protect themselves from WNV infection (n=108), and refusal to accept a WNV vaccine (n=21). Most of these responses fell into an "Other" category which allowed respondents to provide free-form answers rather than choose from a list of options. A set of overarching themes classifying respondents' risk perceptions were developed. The themes included: (1) professed knowledge of WNV prevention, (2) perception of immunity to WNV infection, (3) sense of inevitability (of illness), and (4) perception of faith or good fortune.

Professed Knowledge of WNV Transmission and Prevention

Respondents initially appeared knowledgeable about WNV transmission, correctly identifying that it is spread by mosquito bites. But this apparent knowledge disappeared when respondents explained their reasons for not taking preventive measures. For example, 113 respondents indicated that they were not worried about getting sick with WNV, and when asked why they are not worried or only a little worried about contracting WNV, respondents' answers suggested participants believe WNV can be spread through poor personal hygiene, lack of vaccination (there is not yet a WNV vaccine for humans), and casual human contact, none of which are actual modes of WNV transmission. Wieland and colleagues (2012) found similar lack of knowledge and misconceptions about tuberculosis (TB) transmission in their HBM-based focus group study of immigrants and refugees' risk perceptions of TB (Wieland et al., 2012).

Perception of Immunity to WNV

Of the 113 respondents who indicated a reason why they are not worried about getting WNV, six (5%) respondents stated it was because they felt immune to WNV infection. Their responses to questions about why they believe it is unlikely they will get WNV disease suggest some individuals believe it simply is not possible for them to be infected with WNV due to either personal immunity or general feelings of invincibility. McCauley and colleagues noted similar perceptions in their 2013 qualitative study of media framing, stigma and coping related to the H1N1 pandemic, finding that some respondents described a belief that the outbreak was "not so bad" and that their likelihood of getting the disease was low (McCauley, Minsky, & Visnawath, 2013).

Lack of Control over Fate

Similarly, other respondents indicated a lack of control over such disease occurrence, claiming events in life occur entirely at random and cannot be prevented. Wong and AbuBakar (2013) reported similar perceptions of fate or random chance in their study of Malaysian citizens' health beliefs and practices related to dengue fever, another mosquito-borne disease. In that study, focus group participants indicated that dengue occurs because of "bad luck, chance, fate, or uncontrollable factors."

Religious Influence

Finally, some respondents expressed a belief in a higher power that would protect them from WNV, and that as such protection from the disease was not under their control. Many expressed a belief in God to ensure their good health. Such responses allude to a belief in a deity or other external force that would protect them from WNV illness. McCauley et al. (2013) also noted a strong religious influence of God in their 2013 study of US adults in the New England area regarding their perceptions and coping mechanisms relative to the 2009 H1N1 outbreak.

No prior studies have reported detailed qualitative perceptions and opinions of adults ≥60 years old collected in this open-ended fashion. The thematic areas that emerged during this analysis proved illuminating because they revealed an underlying discrepancy in WNV knowledge as measured by the survey questions and actual knowledge of a subset of respondents.

5.6 Implications of Findings

The findings from this study have a number of implications for research and practice. Prior studies examining vaccine acceptance for vaccine-preventable diseases have noted the important role of susceptibility as a motivational factor (Bish et al., 2011; Flood et al., 2010). Vaccination is considered a form of primary prevention because it is a precautionary action taken by individuals to protect them from disease, rather than action taken in response to either signs or symptoms or recognition of the possibility of asymptomatic disease. It highlights the importance of individual cognitions toward the effectiveness of such preventive actions (Poss, 2001). A high proportion of our respondents indicated willingness to accept a WNV vaccine; and, many were motivated to do so based on their personal feelings of vulnerability to WNV.

Despite the finding that the majority of survey respondents correctly identified mosquitoes as the vector of WNV, qualitative results suggest otherwise. Further, the low levels of worry noted in this study may be attributed to a lack of knowledge about how WNV is transmitted and which groups are most at risk for WNV infection. Beaujean and colleagues (2013) found that low perceptions of vulnerability to Lyme disease were caused by a lack of knowledge or awareness that insect repellent can protect against tick bites. A similar lack of knowledge could account for the low levels of worry seen in this study. Therefore it may be useful for public health professionals to reinforce messages explaining how WNV is spread, emphasizing that adults 50 years of age and older are at greatest risk of severe disease.

In their study on the development of risk communication frameworks for Lyme disease in the UK countryside, Quine et al. (2011) emphasized a dilemma faced by health professionals: any messages promoting the risks of a condition could compromise concurrent messages touting the benefits of protective behavior. A large body of literature has been devoted to gain-framed versus loss-framed messages, which focus on promoting the positive benefits of engaging in a desired health behavior and highlighting the adverse affects of not engaging in the behavior, respectively (Quine et al., 2011; Nan, 2012). Too much emphasis on the latter could engender a widespread fear that prevents the target audience from taking any action and can lead to information avoidance, in which individuals avoid any health information that causes mental or emotional discomfort or dissonance (Case, Andrews, Johnson, & Allard, 2005). Therefore, public health professionals must seek to strike a balance between conveying the benefits of engaging in WNV PPBs and stressing the risks of not doing so.

In addition, the high proportion of respondents expressing support for a WNV vaccine and for community mosquito control programs suggests a willingness among this population to support community level, and even federal-level, efforts to reduce the incidence of WNV. Accordingly, there may be a need to increase institutional support for vaccine development and community mosquito abatement efforts. For vaccine development, this would call for allocation of funds to support the design and manufacture of a viable WNV vaccine. Most importantly, it would require building the public's trust in the safety, efficacy, and overall benefit of the vaccine.

Similar challenges were faced by researchers seeking to enhance the uptake of seasonal and pandemic (H1N1) influenza vaccine. As described by Prati and colleagues

(2011) in their study of compliance with recommendations for 2009 H1N1 vaccine, trust in both the media and government health agencies, along with feelings of worry and perceived severity of illness are powerful predictors of behavior (Prati, Pietrantoni, & Zani, 2011). Thus, it is important to engage in outreach efforts and messaging that build trust. Bults et al. (2011) also found reliability of government health agencies to be a significant factor in predicting acceptance of H1N1 vaccine (Bults et al., 2011). Furthermore, Gargano et al. (2011) determined that social norms, a measure of the extent to which significant others in a person's life, including his/her family, friends, health care provider and others, approve of him/her getting the 2009 H1N1 vaccine (Gargano et al., 2011), was a significant predictor of actual vaccine uptake. The same may be true for WNV vaccine uptake, so any development and marketing efforts should take into account social norms regarding vaccine as a preventive tool against WNV disease.

There would also be a need to make financial resources available to local jurisdictions to allow them to implement more widespread mosquito control efforts. At present, community mosquito control in Maryland requires that communities "buy-in", which calls for coverage of 50% of the cost of mosquito abatement; while the Maryland Department of Agriculture (MDA) covers the remainder. Spraying is only done in communities that have formally enrolled in the program by covering half the overall cost. Given the expense involved, some community leaders may believe mosquito control is not a worthwhile investment and others may have concerns about the potential toxicity of repellents in their neighborhoods (MDA Mosquito Control Survey Results, 2006). Community-level education and financial support would be needed to overcome these barriers. Finally, a need exists to better understand why older adults in this high-risk age group, those 70 and above, do not engage in WNV PPBs with the same frequency that their younger counterparts do.

5.7 Implications for Public Health Practice

The findings of this study suggest a number of implications for public health practice. The high percentages of study participants who expressed a willingness to accept a WNV vaccine and to support community mosquito control efforts suggest receptivity among this population for WNV prevention interventions at both the individual and community levels. Specifically, there may be some benefit in designing and implementing targeted outreach interventions to reinforce prevention messages to adults ≥60 years old. Such interventions could involve information fairs at senior centers in which WNV literature is distributed that explains and encourages PPB practice, or focus groups among older adults at churches or other faith-based institutions and senior community centers to solicit input and opinions from this age group about their worries and fears related to WNV. In addition, direct efforts could be made to increase knowledge and awareness of the potentially severe effects of WNV disease through tailored and targeted media outreach efforts.

In spring 2014, the Maryland Department of Health and Mental Hygiene launched Tick-borne Disease Awareness Month in May, which featured a Governor's proclamation and several online outreach efforts, including Twitter messages and online fact sheets about the risks and prevention steps to reduce the risk of Lyme disease and other tick-borne diseases. A similar campaign could be launched in the form of Mosquito-borne Disease Awareness Month, which could include a special focus on messages targeting adults ≥60 years old with fact sheets, mailed literature, and televised PSAs that emphasize the risks of WNV for this age group. Finally, in light of the seasonal nature of WNV and other mosquito-borne diseases, it may also be worthwhile for local health officials to partner with cooperative extensions offices to offer educational seminars in the spring and summer that emphasize WNV prevention measures such as dressing long shirts and pants when outdoors in summer, and applying insect repellent to exposed skin when outside. These seminars could be incorporated into existing extension programs such as Master Gardener training workshops and crop management information fairs.

Interventions such as those described above represent a method to translate the findings of this study into direct actions by state and local public health officials that could directly benefit those at highest risk of severe WNV disease: adults ≥60 years old.

5.8 Implications for Theory

The Health Belief Model served as the theoretical framework for this study and was chosen because of a small but growing body of evidence of its potential utility in previous studies of WNV prevention behavior. Previous studies have suggest the HBM is an appropriate choice for application to a study of WNV preventive behaviors, because it involves examination of individual perceptions and beliefs about personal risk and severity of disease as well as about emotional and tangible benefits and barriers to engaging in personal protective behaviors. Despite this, the findings of this dissertation also reveal potential weaknesses of the HBM in predicting WNV preventive behavior. Because WNV is a communicable disease spread to humans by a mosquito vector, has a very clearly defined risk group (adults 50 years old and older), potentially severe health consequences for high-risk individuals (severe illness, hospitalization, and even death), and specific steps/behaviors can be performed to reduce the risk of infection, it is a suitable disease for application of the HBM. However, this assumption of applicability was only partly borne out in the study.

Disagreement persists within the research community regarding which HBM constructs are the best predictors of individual behavior. Although many have argued that perceived barriers represent the strongest predictor of behavior (Murray-Johnson, 2006; Carpenter, 2010), results of this study do not provide evidence for this relationship regarding WNV PPBs. Furthermore, perceived severity and self-efficacy constructs have been previously identified as key predictors of PPB outcomes, but this assertion was also not consistent with findings in this study. Neither perceived severity, perceived barriers, cues to action, nor self-efficacy were significant predictors of WNV PPBs.

As noted in the discussion of HBM strengths and weaknesses in Chapter 2, it is possible the HBM may be better suited to explaining short-term or “one-shot” behaviors (such as vaccination), rather than long-term practices, such as taking medication for a chronic condition, maintaining dietary habits, or routinely eliminating standing water from objects on one’s property. In addition, as has been noted in the past, it is often difficult to operationalize and properly measure HBM constructs when designing survey instruments. This challenge was present in this study as well, and since the survey instrument used for the study was not tested for validity or reliability, this author cannot state with certainty that the survey questions adequately captured the HBM constructs for this study population.

Research on the utility and efficacy of the HBM for assessing individual attitudes, perceptions, and behaviors toward different diseases has been plagued by inconsistencies, as noted by Jones et al. (2014). Of the four meta-analyses conducted to examine the viability of the HBM between the 1970s and the present, two found the model had weak overall predictive power (Harrison, Mullen, & Green, 1992; Zimmerman & Vernberg, 1994), one identified perceived barriers alone as the strongest predictor, and one found perceived barriers and benefits collectively to be the strongest predictors of health behavior (Carpenter, 2010). Jones et al. (2014) described a hierarchy of HBM constructs arising from these conflicting results, and sought to resolve the conflict by using an H1N1 vaccination promotion campaign to compare three different strategies for applying the HBM to a health promotion initiative.

The first strategy involved parallel mediation, in which all HBM constructs were thought to be influenced by the same independent variable (campaign exposure) and thought to have no influence on each other; the second approach was termed serial mediation, and regarded all constructs as a causal chain affecting a single outcome (vaccine uptake); the third approach, moderated mediation, assumed that one HBM construct acted as a moderator for all the others (Jones et al, 2014). Each of the three approaches placed the HBM constructs in a different sequence or order in an effort to see which one was most predictive of campaign effectiveness. Jones and colleagues (2014) found that in parallel mediation analysis, perceived barriers mediated the relationship between exposure and behavior, that serial mediation suggested a causal chain linking both perceived barriers and benefits to H1N1 vaccine uptake, and that moderated mediation showed self-efficacy as a mediator of barriers and perceived threat. They concluded that the varying results for each strategy suggest a potential hierarchy for examination of HBM constructs in future research (Jones et al, 2014). In a similar manner it is possible that some of the HBM constructs examined in this dissertation were also moderated by another variable or construct.

The findings by Jones and colleagues (2014) may hold relevance for future studies applying the HBM to mosquito-borne disease prevention efforts, as they suggest it may be worthwhile to undertake a competitive hypothesis testing approach, in which the HBM is tested against one or more other health behavior theories to identify alternative pathways linking constructs (Jones et al., 2014; Murphy, Vernon, Diamond, & Tiro, 2014; Brewer & Gilkey, 2013). As described by Brewer and Gilkey (2013), in the competitive hypothesis testing approach, a single theory is treated as a divisible set of constructs , based on the assumption that predictions from the theory represent distinct arguments that can be examined separately, rather than as a unified whole. This differs from the traditional summary approach to theory testing, in which each theory is treated as a system of constructs, intended to remain unbroken (although this is often not the case in practice) (Brewer & Gilkey, 2013). The competitive approach may be appropriate for future theory-based studies of WNV personal protective behavior, as each of the HBM constructs examined in this study appeared to act independently of one another. In light of the finding that perceived susceptibility and perceived benefits were both significant predictors of WNV PPBs in this study, while the other HBM constructs were not, there may be some benefit to competitive testing of the HBM against another widely-used theory in future WNV prevention studies, to see if the same associations hold.

Among the variety of health behavior theories currently in use today, including the HBM, Theory of Reasoned Action (TRA) and Theory of Planned Behavior (TPB), and the Transtheoretical Model, an overlap exists among conceptual definitions across constructs, as noted by Murphy et al (2014) and many others. That is, the same construct may be named or defined differently from one theory to the next: perceptions of the net advantages and disadvantages of engaging in a protective health behavior are termed perceived benefits and barriers, respectively, in the HBM, while in the TRA/TPB they are referred to as attitude (Murphy et al., 2014). Given this pattern of overlapping constructs, it is plausible that other health behavior theories might also be applied to the study of knowledge, attitudes, and practices toward WNV prevention, perhaps with different results. Furthermore, as noted in the discussion of perceived susceptibility and worry earlier in this chapter, a call has been issued for future theory-based research to incorporate aspects of emotional affect into the application of theory to predicting practice of protective health behaviors (Freimuth & Hovick, 2012). Accordingly, there may be some merit in conducting future theory-based studies that probe the influence of worry, anxiety, and other measures of emotional affect on individuals' engagement in WNV PPBs.

In their study examining anxiety, worry, and cognitive risk perceptions associated with the H1N1 pandemic in Hong Kong in 2009, Liao and colleagues (2014) concluded perceived susceptibility involves optimistic bias (the mistaken belief that one's chances of experiencing an adverse disease outcome are lower than one's peers) and incorporates social comparison. Similarly, the findings of this study, which revealed a strong role of perceived susceptibility in predicting personal protective behaviors, despite overall low perceptions of vulnerability to WNV infection, may also reflect an underlying perception by respondents that they are less likely than their peers to get infected with WNV. In addition, the finding in this study that persons who perceive benefits in performing mosquito source reduction by repairing damaged window screens are significantly more likely to also drain standing water from objects around their home may suggest a form of optimistic bias, in which respondents knowledgeable about the benefit of such actions perceive themselves superior to (or more protected than) their peers.

The timing of WNV epidemics also plays a role in risk perception, as measured by theory. As documented in studies of knowledge, attitudes, and response to the 2009 H1N1 pandemic influenza outbreak, perceptions of worry about the disease and motivations to take preventive action varied according to the stage of the outbreak (Liao et al., 2014; Renner & Reuter, 2012). Since this dissertation study was initiated at the conclusion of one of the largest nationwide outbreaks of WNV neuroinvasive disease, public awareness of WNV was likely high, despite the noted limited concern for personal vulnerability to it. A need exists for further research to explore the utility of the HBM and other health behavior models at explaining risk perceptions and preventive behaviors relative to WNV and other communicable mosquito-borne diseases.

5.9 Study Limitations

The study used a cross-sectional design and relied on self-reported data collected via telephone, which prevented interviewers from validating respondents' answers. The sampling frame only included eligible residents with a landline phone number; thus, results may not be generalizable to Maryland residents without phones. In addition, social desirability bias may have been operative. Respondents may have sought to project a more favorable image when reporting demographic and lifestyle characteristics to the interviewers, so as to give the impression of greater wealth, education, and/or social standing. Furthermore, recruitment of study participants involved purchase of a list of household phone numbers and addresses from a social marketing firm that drew its data from census records and other sources. Any gaps in those data sources may have contributed to selection bias during sample recruitment.

The sampling methods also represented a limitation. Most survey participants had a college degree or higher and therefore may not have been representative of the majority of residents in the counties from which they were sampled. Lack of sufficient statistical power, due to the fact that the PPB outcomes were measured individually rather than as a composite measure, is another potential limitation. In addition, the operationalization of some HBM variables may have influenced the observed associations between the theory constructs and the designated outcomes: had some constructs been conceptualized differently it may have resulted in more research hypotheses being supported. For example, if the self-efficacy construct had been operationalized to ask about a specific behavior, such as "how confident are you that you can identify and drain standing water from objects around your home" instead of as "how confident are you that you can protect yourself and your household members from WNV," this may have been more likely to yield significant associations between the self-efficacy construct and selected PPB outcomes.

The timing of survey administration posed another limitation. Due to delays in the process of obtaining CDC approval, and in completing the DHMH IRB approval, revision, and modification process, survey administration began in October 2012, as the WNV surveillance season was drawing to a close. As a result, respondents may have been more likely to experience recall bias while attempting to recall their feelings and actions regarding WNV protective behaviors they performed during the summer (such as frequency of applying insect repellent in the last 90 days). In addition, due to the approaching winter holidays, survey administration was terminated in mid-December, even though calls to the sample of 1,700 households had not all been made (n=1,090 households). The resulting smaller subset of persons called may have excluded potential enrollees whose attitudes and behaviors toward WNV may have differed from those of study enrollees.

5.10 Future Research Directions

These study results suggest a number of implications for future research. Future research efforts should consider reconfiguring the PPB outcomes as a single composite measure, rather than as individual outcomes. It is possible that if the PPBs were summed and coded on a numeric scale in which respondents are scored based on a dichotomous variable (i.e. performing one or more PPBs vs. none), and that summed variable were tested as a single outcome, this may have resulted in more significant associations between the HBM constructs and PPBs.

In addition to the research implications for worry about WNV infection, which is described earlier in the chapter, future research is also needed to examine the role of perceived benefits in predicting use of insect repellent and support for community mosquito control programs. Several of the survey questions included open-ended responses that allowed respondents to explain their responses, such as why they are not worried about WNV, why they feel confident they can protect themselves against WNV, and why they are not willing to accept a WNV vaccine. While a formal examination of the qualitative data was beyond the scope of this study, a thorough qualitative analysis of those responses is warranted. Findings from such research could be useful in understanding the knowledge, beliefs, and perceptions that informed respondents' behaviors.

With respect to environmental health research and policy, study findings suggest avenues for further exploration as it relates to insect repellent use. Given the barriers and concerns study participants noted with regard to insect repellent use, specifically concerns about its potential toxicity and safety, future research efforts should examine the basis for such concerns. Knowledge, attitudes, and other psychosocial factors related to pesticide use have been examined largely among populations of migrant farm workers and other agricultural professionals (Arcury, Estrada, & Quandt, 2010; LePrevost, Blanchard, & Cope, 2011; Rios-Gonzalez, Jansen, & Javier, 2013). Rarely has a theory-based study examined knowledge, attitudes and behaviors toward pesticide use among older adults at risk for WNV or other mosquito-borne disease.

Furthermore, from an environmental perspective, these study findings also have implications for climate change research. Research efforts abound seeking to explore associations between climate change phenomena and the incidence and geographic distribution of WNV and other vector-borne diseases as well as individual social and behavioral responses to climate effects on disease events (Wei et al., 2014; Le Dang Nuberg, & Bruwer, 2014; Gubler et al., 2001). Future research that further probes factors influencing individuals' risk perceptions, attitudes, and cues that prompt them to engage in protective behaviors may be useful in further elucidating the relationship between climate change and WNV incidence, as informed by personal behaviors.

In addition, like age, knowledge of WNV transmission was also a significant predictor of a single PPB: draining standing water. Future research efforts should consider ways to examine the role of knowledge in other WNV prevention efforts and see if knowledge remains predictive for other age groups.

5.11 Summary and Conclusions

Maryland adults ≥ 60 years old demonstrated considerable support for community-level efforts to prevent WNV, namely vaccine development and community mosquito control programs. Therefore it is vital to promote such initiatives, as they are likely to be well-received by this high-risk age group. Furthermore, the significant associations identified between perceived susceptibility to WNV and perceived benefits of selected PPBs on engagement in PPBs among this population underscores the importance of communicating WNV disease risk and the value of WNV PPBs to this community. They also underscore the need for exploratory research to consider new methods of risk communication and message framing to incorporate elements of worry and perceived benefits into WNV prevention messages. Finally, since adults 60 to 69 years old are more likely than their older counterparts to actively engage in PPBs, further research may have merit in helping public health professionals understand the reasons for that age discrepancy.

APPENDIX A: INTRODUCTORY LETTER

STATE OF MARYLAND

DHMH

Maryland Department of Health and Mental Hygiene

201 W. Preston Street • Baltimore, MD 21201

Martin O'Malley, Governor – Anthony G. Brown, Lt. Governor – Joshua M. Sharfstein, M.D., Secretary

[Date]

Name
Street Address
City, MD Zip code

Dear [Name]:

The Maryland Department of Health and Mental Hygiene is doing a survey to learn about West Nile virus, a health condition that may be of interest in your community. The study results will help Maryland public health workers develop educational programs to help people avoid getting sick with West Nile virus.

We are contacting you because your household was picked at random from a publicly available database of households in Maryland.

Someone from the health department may call you and ask if you would like to be part of this study. If you agree to participate, you will be asked a series of questions that take about 15 minutes to complete, and that is all you have to do.

We hope you will participate. If you would like to take part or learn more about the study, you can indicate your interest on the enclosed postcard and list a good time for us to call. If you do not want to take part in the study, please indicate that on the postcard and return it by mail.

Thank you for your help.

Sincerely,

Kimberly C. Mitchell, MPH
Chief, Rabies and Vector-borne Diseases
Center for Zoonotic and Vector-borne Diseases

Enclosures: Pre-contact Response Postcard

Toll Free 1-877-4MD-DHMH – TTY/Maryland Relay Service 1-800-735-2258
Web Site: www.dhmh.state.md.us

APPENDIX B: RESPONSE POSTCARD

PRE-CONTACT RESPONSE POSTCARD

Front:

KIMBERLY C. MITCHELL, MPH
201 WEST PRESTON STREET, ROOM 317
BALTIMORE, MD 21201

Back:

ASSESSING BARRIERS TO PREVENTION OF WEST NILE VIRUS IN ADULTS AT LEAST 60 YEARS OLD IN MARYLAND

☐ I would like to learn more about this study. You can contact me at:

Your name______________________________ Phone ___________________

Date______________________________________ Time_____________ AM / PM

☐ Please do not contact me. I do not want to take part in this study.

Study ID # ______________

APPENDIX C: WEST NILE VIRUS KNOWLEDGE, ATTITUDES, AND BEHAVIOR QUESTIONNAIRE

PHONE SCRIPT

GREETING AND IDENTIFICATION OF POTENTIAL ENROLLEE

1. TO THE PERSON WHO ANSWERS THE PHONE, IF ADULT, OTHERWISE ASK TO SPEAK TO AN ADULT: Hello, my name is _________. I'm calling from the MARYLAND DEPARTMENT OF HEALTH AND MENTAL HYGIENE and trying to reach Mr./Mrs. _________. We are doing a survey with the Centers for Disease Control and Prevention about West Nile Virus. A letter was sent to your home introducing the study and indicating that we are interested in talking with adults 60 years of age and older. Is anyone residing in your home 60 years old or older?

   [If No] Thank you for your time. [Terminate interview] =STOP=

   [If yes] How many people at or above the age of 60 years old live in your home?

   - [If 1 person] May I please speak with this individual?
     - If person who answered is potential enrollee, go to Survey description
     - If person coming to the phone, go to Q2
     - If person not home at this time, go to Q1.1
     - If not a good time, go to Q1.1
     - If person does not speak English, s/he is not eligible. =STOP=
   - [If >1 person] Among the [#] individuals you mentioned, whose birthday will occur next?
     - May I please speak with that individual?
       - If person is potential enrollee, go to Survey description
       - If person coming to the phone, go to Q2
       - If person not home at this time, go to Q1.1
       - If not a good time, go to Q1.1
       - If voicemail go to Q1.2
       - If person does not speak English, s/he is not eligible. =STOP=

   1.1 IF POTENTIAL ENROLLEE NOT HOME OR IF NOT A GOOD TIME: His/her participation in this research study is very important. When would be a good time to reach him/her? RECORD PERSON'S NAME TO ASK FOR AND DAY/TIME TO CALL. Thank you for your time. I will call again at that time. Good-bye. =STOP=

   1.2 If voicemail:

   "Hello, my name is _________ and I am calling from the Maryland Department of Health for Mr./Mrs. ____________. We are interested in talking with adults 60 years of age and older about West Nile virus. If you or a member of your household is at least 60 years old, please call us at 410-767-5649 as we would very much like to talk with you. Thank you."

2. Hello my name is _________. I'm calling from the MARYLAND DEPARTMENT OF HEALTH AND MENTAL HYGIENE. We are doing a survey about West Nile Virus. Specifically, we are interested in talking with adults 60 years of age and older. I would like to confirm that you are in that age group. Are you at least 60 years of age?

___ If Yes, go to Survey Description ___ No; go to Q2.1.

2.1 IF NO, May I speak with him/her?

___ NOT AT HOME; GO TO Q2.2. ___ Yes; COMING TO THE PHONE; GO BACK TO Q2.

___ No; Thank you for your time. =STOP=

2.2 Is there another phone number where I could reach him/her?

___ Yes; RECORD ALTERNATE PHONE NUMBER. Thank you very much for your time. =STOP=

___ No; When would be a good time to call back to reach him/her? [RECORD DAY/ TIME]. Thank you very much for your time. =STOP=

Survey Description [Once age/randomization criteria have been met]

Now, I'd like to tell you a little bit more about this survey. We are talking with adults 60 years of age and older to learn about things you may already be doing around your home that would protect you from a disease caused by the West Nile virus, what you know about this disease, and your opinions about ways in which we might help protect your community from this disease. We will use this information to develop educational materials and other programs to help protect people from getting sick with this disease.

It will take about 10 to 15 minutes to answer these questions. We will not ask you any questions about your health or that of any other members of your household. Your answers will not be linked to your name, address or other information that may identify you. Likewise, we will not use your name, address or any other identifying information in any reports or materials that we may publish. Your participation in this survey is completely voluntary. At any time, you may decide that you do not want to answer a specific question. That is OK. If you decide that you do not want to finish the interview that is OK too. However, your answers are very important and will help us develop better programs to serve your community.

We used a publicly available source of information to identify households located in the communities of interest to us. However, we know that this information is sometimes not correct.

3. Would you be willing to answer two questions so that we can make sure that you are eligible to participate in this survey? ___ Yes ___ No

If NO: Your participation in this research study is very important. We are trying to determine what adults 60 years old and over know about how to prevent West Nile Virus. May I schedule a time to talk that would be better for you?

___ Yes; RECORD DAY/TIME. Thank you very much for your time. =STOP=

___No, sorry to have disturbed you. Good-bye. =STOP=

If YES: Thank you. In what zip code do you live? [PLEASE CHECK BOX NEXT TO APPROPRIATE ZIP CODE]

Zip codes	**Zip codes**
☐ 20902	☐ 21214
☐ 20910	☐ 21215
☐ 21014	☐ 21222
☐ 21060	☐ 21224
☐ 21122	☐ 21228
☐ 21212	

If Potential Enrollee does not live in one of the listed zip codes then:
READ: I'm sorry; the zip code in which you live is not one of our study zip codes. Thank you for your interest in participating.

READ: In what type of housing do you live? [LIST ITEMS BELOW]

1. Single-family detached home
2. Townhouse or condominium
3. Apartment
4. Active living senior community
5. Other housing: ______________________________

If Potential Enrollee lives in a long-term care facility, nursing home, or institution, then ineligible to participate:

READ: I'm sorry, you are not eligible to participate based on your housing.

<u>Verbal Consent</u> [IF ALL ELIGIBILITY CRITERIA ARE MET]

READ: It seems that the information we had about your household is correct. I would now like to ask you our survey questions. But before I do so, do you have any questions for me?

If yes, answer questions.

If no, continue

READ: Now, or at any time during or after the survey, you may also contact Kim Mitchell, MPH, WNV Prevention Project Coordinator at 410-767-5649 with any questions about this project or Gay Hutchen Administrator, DHMH Institutional Review Board, at 410-767-8448 with any questions you may have about your rights as a survey participant.

At the end of the survey, I will also provide you with an opportunity to receive a written description of this project including who to contact with any further questions.

Are you willing to take part in this survey? ___ Yes ___ No Interviewer's initials ______

If yes, go to first question (Q4).

If no: Your participation in this research study is very important. We are trying to determine what adults 60 years old and above know about how to prevent West Nile Virus. May I schedule a time to talk that would be better for you?

___ Yes; RECORD DAY/TIME. Thank you very much for your time. =STOP=

___ No, thank for their time. Good-bye. =STOP=

BEGIN INTERVIEW

Knowledge of West Nile Virus and Severity of Disease

READ: We are going to start the survey now. These first questions ask about what you know and think about West Nile virus disease.

4. Have you ever heard of West Nile virus?
    a. Yes IF YES, go to Q5.
    b. No IF NO, go to Q4a.
    c. Don't know
    d. Refused

4a. Would you be willing to answer some questions about ways to avoid mosquitoes in the summer? Circle Yes / No.

If yes, skip to Q11.

5. How do you think most people get West Nile virus?
    a. Eating or drinking contaminated food or water
    b. From bug bites, such as mosquito bites
    c. From birds
    d. Contact with sick people
    e. Other (list):____
    f. Don't know
    g. Refused

6. How worried are you that you might get sick with West Nile virus? [READ CATEGORIES]

a. Very worried
b. Somewhat worried
c. A little worried
d. Not at all worried
e. Don't know
f. Refused

6a. If Very worried or somewhat worried: can you tell me why you are worried about getting sick with WNV:
a. I hear about it on the news
b. I know someone who had it
c. I get sick easily
d. Other: ___________________________
e. Don't know

6b. If A Little worried or Not at all worried: can you tell me why you are not worried about getting sick with WNV:
a. I cover up when I go outdoors
b. I use bug spray/repellent
c. I almost never go outside in the summer
d. Mosquitoes are not a problem where I live
e. I don't think WNV is in my area
f. Other: _______________________________

7. Do you think West Nile virus can cause serious illness?
   a. Yes
   b. No
   c. Don't know
   d. Refused

8. What age group do you think is most likely to get seriously ill from West Nile virus? [READ ALL ITEMS]
   a. Young children (0-10 years old)
   b. Adolescents and teenagers (11-18 years old)
   c. Young adults (19-25 years old)
   d. Adults (26-50 years old)
   e. Adults >50 years old
   f. Don't know
   g. Refused

9. On a 1 to 5 scale, with 1 being "not at all likely" and 5 being "extremely likely" how likely do you think it is that you will get West Nile virus in the next calendar year?

Not at all likely	Not very likely	Moderately likely	Very likely	Extremely likely
1	2	3	4	5

9a. IF NOT AT ALL LIKELY TO MODERATELY LIKELY: why do you think it is unlikely, not very likely, or moderately likely that you will get WNV in the next calendar year?

a. I don't go outside
b. I always use repellent
c. I am afraid of mosquitoes
d. No one I know has gotten it
e. Other: ________________________________
f. Don't know
g. Refused

9b. IF VERY LIKELY OR EXTREMELY LIKELY: why do you think it is likely that you will get WNV in the next calendar year?

h. I often spend time outside
i. I never use repellent
j. I do not know how to avoid it
k. Other: _______________________________________
l. Don't know
m. Refused

10. Do you know anyone who has had West Nile virus?

a. Yes
b. No
c. Don't know
d. Refused

Prevention

READ: Next I would like to ask you some questions about preventing West Nile virus.

11. How confident are you that you can protect yourself and your household members from getting West Nile virus?

Very confident	Somewhat confident	Not at all confident	Don't Know	Refused
1	2	3	4	5

11a. IF VERY CONFIDENT OR SOMEWHAT CONFIDENT:
Can you tell me what makes you feel confident that you can protect yourself and your household members from WNV (circle all that apply)?

a. I always use insect repellent and encourage others in the house to use it
b. I do not go outside when mosquitoes are active
c. I empty containers holding standing water on my property
d. I educate others in my household about how to avoid mosquito bites
e. Other [ASK RESPONDENT TO LIST]: _____________________
f. Don't know
g. Refused

11b. IF NOT AT ALL CONFIDENT:
Can you tell me why you do not feel confident that you can protect yourself or your family members from WNV (circle all that apply)?
a. I do not know how to prevent WNV
b. I do not know how to use repellent
c. It is too inconvenient to take steps to protect myself and others who live with me
d. Don't know
e. Refused

12. Since the start of this past summer (2012), did you or someone you asked or hired drain water from items around the outside of your home, such as gutters, buckets, flower pots, kiddie pools, bird baths, or discarded tires…?
a. Yes IF YES, GO TO 12a
b. No IF NO, GO TO Q13
c. Don't know
d. Refused

12a. If yes, how many times each summer do you have the water drained from those objects around your home? ____ [INDICATE APPROXIMATE NUMBER OF TIMES]

13. [IF NO], can you tell me why you do not drain water from items on your property that may collect water [Circle all that apply]?
a. It takes too much effort (e.g., too time consuming, not enough energy, or too heavy)
b. I do not have anyone to help me
c. It is too dangerous
d. I use products (e.g., mosquito-dunks) in the containers to keep mosquitoes from breeding in the water
e. There is nothing that collects water in my yard
f. I do not own my home
g. Other (list)____
h. Don't know
i. Refused

14. How do you keep your home cool in the summer (circle all that apply)?
a. Fans– GO TO Q16
b. Air-conditioning– GO TO Q16
c. Open windows – GO TO Q14a
d. Other (list): ____
e. Don't know
f. Refused

14a. [If open windows, ASK] do all of the windows in your home have screens?

a. Yes
b. No
c. Don't know
d. Refused

14b. [IF YES (ALL WINDOWS HAVE SCREENS)] are your screens in good condition (i.e., no holes or tears)?

a. Yes
b. No IF NO, GO TO 14c
c. Don't know
d. Refused

14c. [IF NO, ASK], can you tell me why you have not repaired the damaged screens?

a. It takes too much effort (e.g., too time-consuming, not enough energy)
b. They are too difficult to check or repair
c. I do not have anyone to help me
d. It is too expensive
e. I did not think it would help
f. Not applicable—I do not own my home
g. Other: [ASK RESPONDENT TO LIST:]____________________________

15. Would you be interested in a community program to help adults over 60 years old repair their damaged window screens and dump standing water in yard?

e. Yes
f. No
g. Not applicable—I do not own my home
h. Don't know
i. Refused

15a. [IF YES, ASK] how do you think the program should be supported?

____

READ: These next few questions are about programs in your community.

16. Are you aware of any government programs that use pesticides (i.e., larvicides or insecticides) to reduce mosquitoes in your community?

a. Yes
b. No
c. Refused

17. Are you or would you be in favor of a mosquito control program like that?

a. Yes
b. No

c. Don't know
d. Refused

18. Are you in favor of tax money being used to support mosquito control programs in your community?
    a. Yes
    b. No
    c. Don't know
    d. Refused

18a. If no, how do you think a mosquito control program in the community should be supported?

____

19. Which, if any, of the following insect repellents or other products have you heard of [circle all that apply]?
    a. DEET (N,N-diethyl-meta-toluamide)
    b. Citronella
    c. Picaridin
    d. IR3535
    e. Oil of lemon eucalyptus
    f. Permethrin
    g. Skin So Soft
    h. None of them
    i. Don't know/not sure
    j. Refused

20. In the last 90 days (since the beginning of September), did you always, sometimes, rarely or never use insect repellent on your skin when you went outside?
    a. Always
    b. Sometimes
    c. Rarely
    d. Never

20a. IF RARELY or NEVER, ASK: can you tell me who you rarely or never use insect repellent on your skin (can choose more than one)
    a. I often forget
    b. It feels sticky on my skin
    c. It smells bad
    d. It will make me feel sick or get a rash
    e. It is too expensive
    f. I didn't know it could help
    g. Other: [ASK RESPONDENT TO LIST] _______________
    h. Don't know
    i. Refused

20b. IF RARELY or NEVER, ASK: would you be more likely to use insect repellent if it were [can choose more than one]:

a. Given away free at community centers or other places
b. Sent to you as a free sample in the mail
c. Odorless
d. Did not leave a residue on skin
e. Other [ASK RESPONDENT TO LIST]: ____________________________
f. Don't know
g. Refused

21. In the summer months, about how many hours do you spend outside during the day: _______ [please list a number or range]
    a. Don't know
    b. Refused

21b. When you do go outdoors, is it usually:

c. At dusk or dawn
d. In the middle of the day

22. When you go outdoors during the summer, do you wear long-sleeved shirts and/or long pants?
    a. Yes – GO TO Q22a
    b. No – GO TO Q23
    c. Don't know
    d. Refused

22a. If yes, at what time of day do you dress in long-sleeved shirts and/or long pants?

e. At dusk or dawn
f. In the middle of the day

23. If there were a West Nile virus vaccine available that is both safe and effective, would you be willing to take it?
    a. Yes – GO TO Q23b
    b. No – GO TO Q23a
    c. Maybe
    d. Don't know
    e. Refused

23a. IF NO, please indicate why not:

a. I don't like vaccines
b. I don't believe it would work
c. I am afraid of needles

d. I am afraid it would make me sick
e. I am not worried about getting West Nile virus
f. Other: ___________________________

23b. If YES and the vaccine was not covered under your health insurance plan, how much would you be willing to pay out of pocket for the vaccine?

a. $0
b. <$25
c. $25-49
d. $50-74
e. $75-99
f. >$100

Educational material

READ: These next questions ask about how to distribute information about WNV.

24. In the last year, have you received information in any form about West Nile virus (this can be written material, electronic media, word-of-mouth, or some other method)?
    a. Yes
    b. No
    c. Don't know
    d. Refused

24a. [IF YES] please tell me who provided it or in what form that information was provided [can choose more than one]:

a. Doctor or other health care provider
b. Radio [ASK RESPONDENT TO LIST STATION __________]
c. Television [ASK RESPONDENT TO LIST CHANNEL________]
d. Newspaper [If yes, ASK RESPONDENT TO NAME:] ___________________
e. Internet or website [If yes, ASK WHICH ONE:] ___________________
f. Magazine [If yes, ASK RESPONDENT TO NAME:] ___________________
g. Other written material (brochure, newsletter, flyer, fact sheet, door hanger)
h. E-mail
i. Mail
j. Word of mouth
k. Other [PLEASE ASK RESPONDENT TO LIST:] ___________________
l. Don't know
m. Refused

25. How do you prefer to get information about health issues and health care services [can choose more than one]?

a. Doctor or healthcare provider
b. Radio
c. Television news
d. Internet/e-mail
e. Mail
f. Newspaper
g. Public gatherings (e.g., health fairs, senior center events)
h. Other [ASK RESPONDENT TO LIST:]: ______________________
i. Don't know
j. Refused

Demographic
READ: These last few question are about you.

26. Is your home located?
    a. In a city
    b. In the suburbs
    c. In a rural area
    d. Refused

27. Do you own your home?
    a. Yes
    b. No
    c. Don't know
    d. Refused

28. How long have you lived at your current residence: ___ [approximate months or years]

29. Would you please tell me the age and gender of yourself and the other people in your household who are 60 years old or older? [List respondent age and sex on line #1]

Age	Gender	Age	Gender
1.		5.	
2.		6.	
3.		7.	
4.		8.	

30. Are you Hispanic or Latino/a or of Spanish origin? Yes ___No ___

31. How would you describe your race? You can list more than one category.
    CHECK ALL THAT APPLY.

❑ White or Caucasian
❑ Black or African American
❑ Asian
❑ Native Hawaiian or other Pacific Islander
❑ American Indian/Alaska Native/Chicano/Mestizo

DO NOT READ: ❑ Other [specify] ___________________
❑ Don't know or not sure
❑ Refused

32. What is the primary language spoken in your household?
 a. English
 b. Spanish
 c. Other: ______________________________
 d. Refused

33. What is the highest level of education you have completed (circle only one)?
 a. Some high school
 b. High school Diploma or GED
 c. Some college, including Associate degree
 d. Bachelor's degree
 e. Some graduate school
 f. Graduate degree
 g. Refused

34. What is your marital status?
 a. Married
 b. Single
 c. Separated
 d. Divorced
 e. Widowed
 f. Refused

35. What is your employment status?
 a. Full time
 b. Part time or "semi-retired"
 c. Retired
 d. Unemployed
 e. Other: [ASK RESPONDENT TO LIST]:
 ____
 f. Refused

36. Which category best describes your total household annual income? [please read categories to respondent and circle answer]

a. ≤ $20,000
b. $20,001 to $30,000
c. $30,001 to $40,000
d. $40,001 to $50,000
e. $50,001 to $60,000
f. $60,001 to $70,000
g. Over $70,000
h. Don't know
i. Refused

That concludes the survey.

Thank you so much for your time. Do you have any questions?

Questions:

____

____

If you would like, I can send you a copy of the information that I provided about the study for your records. I can send it by mail, e-mail, or fax. Yes ___ No ___

[RECORD PREFERENCE; IF APPROPRIATE GET CONTACT INFORMATION]

For Office Use:

Date: ___________________ Time: _______________________________

Administered by [name of interviewer]:

I will send you a copy of the INFORMATION THAT I PROVIDED ABOUT THE STUDY (Project Information Sheet) for your records. Would you prefer that I mail, email or fax the form to you? RECORD PREFERENCE AND GET MAILING ADDRESS, EMAIL, OR FAX NUMBER AS APPROPRIATE.

DETACH PAGE HERE ---

Name: ____

Mailing address: ____

E-mail address: ____

Fax number: ____

APPENDIX D: PROJECT INFORMATION SHEET

Maryland Department of Health and Mental Hygiene

Assessing Barriers to Prevention of West Nile Virus in Persons at Least 60 years old in Maryland

Principal Investigators: Kimberly C. Mitchell, MPH (Maryland DHMH), Katherine Feldman, DVM, MPH (Maryland DHMH)

Introduction
Thank you for taking part in this study by the Maryland Department of Health and Mental Hygiene and the Centers for Disease Control and Prevention. The information you have given us will enable us to plan programs that help people avoid getting sick with West Nile virus and other health conditions that might be of interest to your community. Your household contact information was picked at random by computer from a publicly available database of households in Maryland.

Potential Risks
There were minimal risks involved in this study. Some of the survey questions asked about your income, education, and other information that may usually be kept private.

Benefits
Benefits you may get from this study include the option to be given contact information for local agencies that you may call to get information and resources about West Nile virus. You may contact the WNV Prevention Project Coordinator below to request this information.

Persons to Contact
If you have questions about this study, please contact Kim Mitchell, MPH, WNV Prevention Project Coordinator, at 410-767-5649. If you have questions about your rights as a participant in the study, please contact Ms. Gay Hutchen, Administrator, Maryland Department of Health and Mental Hygiene, Institutional Review Board, 201 West Preston Street, Baltimore, MD 21201, 410-767-8448.

Confidentiality
Your answers will be kept private and will be used only for research. We will not collect your name and your household information will not appear on any project reports or published materials.

Costs
There is no cost to you for completing the survey.

Right to Refuse or Withdraw

This study is completely voluntary. There is no penalty for not participating or not answering all of the survey questions. You did not give up any legal rights by being part of the survey.

APPENDIX E: UMCP IRB APPROVAL LETTER

UNIVERSITY OF MARYLAND

INSTITUTIONAL REVIEW BOARD

1204 Marie Mount Hall
College Park, MD 20742-5125
TEL 301.405.4212
FAX 301.314.1475
irb@umd.edu
www.umresearch.umd.edu/IRB

DATE:	February 28, 2014
TO:	Kimberly Mitchell, MPH
FROM:	University of Maryland College Park (UMCP) IRB
PROJECT TITLE:	[463659-1] ASSESSING KNOWLEDGE, ATTITUDES, AND BEHAVIORS TOWARD WEST NILE VIRUS PREVENTION AMONG ADULTS ≥ 60 YEARS OLD IN MARYLAND: AN APPLICATION OF THE HEALTH BELIEF MODEL
REFERENCE #:	
SUBMISSION TYPE:	New Project
ACTION:	APPROVED
APPROVAL DATE:	February 28, 2014
EXPIRATION DATE:	February 27, 2015
REVIEW TYPE:	Expedited Review
REVIEW CATEGORY:	Expedited review category # 5

Thank you for your submission of New Project materials for this project. The University of Maryland College Park (UMCP) IRB has APPROVED your submission. This approval is based on an appropriate risk/benefit ratio and a project design wherein the risks have been minimized. All research must be conducted in accordance with this approved submission.

This submission has received Expedited Review based on the applicable federal regulation.

Please remember that informed consent is a process beginning with a description of the project and insurance of participant understanding followed by a signed consent form. Informed consent must continue throughout the project via a dialogue between the researcher and research participant. Federal regulations require each participant receive a copy of the signed consent document.

Please note that any revision to previously approved materials must be approved by this committee prior to initiation. Please use the appropriate revision forms for this procedure which are found on the IRBNet Forms and Templates Page.

All UNANTICIPATED PROBLEMS involving risks to subjects or others (UPIRSOs) and SERIOUS and UNEXPECTED adverse events must be reported promptly to this office. Please use the appropriate reporting forms for this procedure. All FDA and sponsor reporting requirements should also be followed.

All NON-COMPLIANCE issues or COMPLAINTS regarding this project must be reported promptly to this office.

This project has been determined to be a Minimal Risk project. Based on the risks, this project requires continuing review by this committee on an annual basis. Please use the appropriate forms for this procedure. Your documentation for continuing review must be received with sufficient time for review and continued approval before the expiration date of February 27, 2015.

Please note that all research records must be retained for a minimum of three years after the completion of the project.

If you have any questions, please contact the IRB Office at 301-405-4212 or irb@umd.edu. Please include your project title and reference number in all correspondence with this committee.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within University of Maryland College Park (UMCP) IRB's records.

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