2022

Health Department Prevention/Education Plans and Perceived Risks of Zika Infection

Lacey Jacques
Walden University

Walden University

College of Health Professions

This is to certify that the doctoral dissertation by

Lacey Jacques

has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
the review committee have been made.

Review Committee
Dr. Aimee Ferraro, Committee Chairperson, Public Health Faculty
Dr. Jamuir Robinson, Committee Member, Public Health Faculty
Dr. Jirina Foltysova, University Reviewer, Public Health Faculty

Chief Academic Officer and Provost
Sue Subocz, Ph.D.

Walden University
2022

Abstract

Health Department Prevention/Education Plans and Perceived Risks of Zika Infection

by

Lacey Jacques

MS, Walden University, 2015

BS, University of California, Riverside, 2010

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Public Health

Walden University

February 2023

Abstract

Zika virus is an infectious disease caused by the bite of an infected mosquito that has been linked to increased rates of microcephaly and other devastating birth defects. The existing body of knowledge has focused on the individual-level factors that influence a person's decisions about prevention activities and risk perceptions related to Zika virus. The purpose of this study was to determine the relationship between state-level plans for prevention and education and individual-level risk perceptions. Rosenstock's health belief model lays a foundation for why individuals make the health decisions they do and helps explain how these can be influenced for better health outcomes. The research questions addressed included understanding the relationship between public health departments' level of engagement for prevention of Zika virus infection and the community's perception of risk of contracting the virus; and the relationship between public health departments' level of engagement for education of Zika virus infection and the community's perception of risk of contracting the virus. A quantitative analysis of two datasets was performed to determine these relationships. An ordered logistic regression analysis was performed on the variables identified to address the research questions. A statistically significant relationship was found between high level of engagement in education activities and low risk perception. The results of this study will help health departments determine how to plan better for future Zika virus outbreaks. The positive social change implication of this study is that with better planning health departments can help reduce adverse health outcomes for their communities.

Health Department Prevention/Education Plans and Perceived Risks of Zika Infection

by

Lacey Jacques

MS, Walden University, 2015

BS, University of California, Riverside, 2010

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Public Health

Walden University

February 2023

Dedication

To my babies, Lucas and Ellie, who were just dreams when this process started and have since grown into interesting and amazing toddlers.

Acknowledgments

I would like to thank my dissertation chair, Dr. Aimee Ferraro, for her patience, understanding, and support throughout the dissertation process.

I would like to thank my mom and husband for their constant support and pride in my academic career. I would not have come this far without them and their gentle pushing to keep me going when I needed it most.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction to the Study

Introduction

Zika virus is an infectious disease transmitted through the bite of an infected mosquito, usually of the *Aedes* family of mosquitoes (Noor & Ahmed, 2018). Infection with Zika virus early in pregnancy has led to a high incidence of microcephaly and other birth defects (Noor & Ahmed, 2018; Wishner et al., 2020). Zika virus typically presents asymptomatically in more than 80% of individuals infected and can be transmitted sexually (Shreve et al., 2019). On February 1, 2016, the World Health Organization (WHO) declared a Public Health Emergency of International Concern due to the suspected link between Zika virus infection during pregnancy and birth defects, such as microcephaly and Guillain-Barré syndrome (Basile et al., 2017).

While several investigational vaccines are under development, including those in early human clinical trials, there are no FDA-approved treatments or vaccines for Zika virus (Food and Drug Administration [FDA], 2021). The positive social change implication of this study would lead to the improvement of the knowledge, attitudes, and practices of the general public regarding Zika and is critical to preventing transmission and infection from Zika. This study addresses the impact that state-level prevention and education efforts have on Zika virus risk perception.

This chapter will describe a brief summary of the existing literature, the gap identified, and the justification for the study. Additionally, the research questions and hypotheses will be outlined, the theoretical framework briefly described, and the nature of the study explained. Finally, this chapter will detail the definitions, assumptions, scope

and delimitations, limitations, positive social change implications, and significance of the study.

Background

Zika virus had a devastating impact on countries in Latin America in 2015 and arrived to certain parts of the United States in 2016. The Zika outbreaks peaked across the world from 2015 to 2017 with the most impact in Latin America. The United States has seen far fewer cases than the rest of the world with no locally transmitted cases to date (Centers for Disease Control and Prevention [CDC], 2021). Transmission of Zika virus in the United States has been attributed to travel-related cases, except for U.S. territories where local transmission remains an issue (CDC, 2021). The type of mosquitoes that are able to transmit Zika virus have been found across the United States and U.S. territories. There is the potential for local transmission of Zika virus if vector control strategies are not implemented in the areas these mosquitoes have been found. The population most at risk of adverse health outcomes due to Zika infection remains to be pregnant women due to the higher rate of microcephaly and other devastating birth defects seen in women who have Zika infections during pregnancy (CDC, 2021).

Health departments have created vector control programs and educational message campaigns to encourage the public to engage in self-protective behaviors, such as removing standing water and eliminating mosquito breeding sites, use of mosquito repellents and protective clothing (Daughton & Paul, 2019; Moise et al., 2018). Additionally, the health departments created guidance for laboratory testing for high-risk populations and surveillance of mosquito populations, pregnant women with confirmed

cases of Zika virus, and fetal outcomes surveillance (McNeill et al., 2016). The education efforts undertaken by health departments were based on the guidance continually updated by the CDC and WHO (Byron & Howard, 2017). These efforts included media campaigns and messages targeted for high-risk populations and local communities that would receive the messages (Brooks et al., 2016; Capitulo, 2016; Shields, 2016).

Zika virus infection rates remain lower in the United States compared to other countries, leading to low perceived risk of infection by Americans. Perceived risk of Zika virus infection is impacted by many factors, such as exposure to health information, residence location, and knowledge of Zika virus transmission routes (Guerre-Reyes et al., 2018; Katler et al., 2017; Winneg et al., 2018). Additionally, perceived risks and behavioral intentions varied across the regions where the respondents lived, and researchers concluded that healthcare providers and the media need to assist in helping educate U.S. travelers on the risks, preventions, and transmission routes of Zika virus (Squiers et al., 2018).

Willingness to engage in protective behaviors has been linked to higher perceived risk of infection and higher levels of Zika virus transmission knowledge (Guerre-Reyes et al., 2018; Katler et al., 2017; Winneg et al., 2018). Johnson conducted two studies, one looking at the self-protective actions (2019b) and one looking at residential location and psychological distance as they relate to perceived risks and behavioral intentions (2018). One study revealed that providing educational information impacted risk perceptions but had no impact on behavioral intentions (Johnson, 2018). Individuals were found to be more likely to practice self-protection when these actions were efficacious and feasible

for their households (Johnson, 2019b). Based on the outcomes of these studies, knowledge of Zika virus risks and preventative actions impacts an individual's perceived risks and behavioral intentions.

Prevention behaviors are influenced by many factors and include many options for actions to be taken to prevent infection. Several studies have shown that the intention to engage in prevention behaviors was impacted by risk perceptions, belonging to a household with a pregnant woman, and knowledge of Zika virus (Chan, Farhadloo, et al., 2018; Jaffe et al, 2020; Ophir & Jamieson, 2018; Reynolds e al., 2019). Prevention behaviors against Zika virus included removal of mosquito breeding sites, wearing protective clothing, practicing safe sex when exposures have taken place, genetically engineered methods, etc. (Daughton & Paul, 2019; Moise et al., 2018). Engagement in prevention behaviors is dependent on many factors and remains crucial for prevention of infection. Factors influencing engagement in prevention behaviors were determined to be knowledge of Zika virus, risk perceptions, removal of barriers to use prevention methods, and confidence in local health and government officials (Ahrens et al., 2017; Berenson et al., 2017; Heitzinger et al., 2018; Hills et al., 2016; Voelker, 2017).

Public health responses to the Zika virus outbreaks were conducted at the local health level, leading to a variety of campaigns and educational efforts. Some of these campaigns and methods proved more effective than others depending on many factors. The inclusion of risk messages in heath campaigns improved the likelihood of prevention method uptake (Chan et al., 2018). Several public health campaign methods and media outlets proved successful at engaging the community in prevention behaviors and

improving overall knowledge about Zika virus transmission, symptoms, and outcomes (Chan et al., 2018; Ellingson et al., 2017; Howells et al., 2018; Prue et al., 2017; Squiers et al., 2019). The WHO and CDC continually updated their health messages and directives to the public and healthcare providers as the data continued to be gathered (Byron & Howard, 2017; Capitulo, 2016; Hatcher, et al., 2016a; Oster, Brooks, et al., 2016; Shields, 2016, Wisner, 2020). Additionally, many local health departments followed this guidance or engaged in collaborative efforts with national level health organizations to support their communities (Earle-Richardson et al., 2018; Hatcher et al., 2016c; Hatcher et al., 2017b; Heberlein-Larson et al., 2019; Philip et al., 2019; Vasquez et al., 2016).

The current (2015-2021) literature addressed risk perceptions, knowledge, prevention behaviors, perceived benefits, perceived barriers, cues to action, and self-efficacy as it related to Zika virus. There was a lack of information on the connection between state-level prevention efforts and individual-level perceptions and behaviors. This study specifically addresses this relationship so health departments can better plan for and react to future Zika outbreaks.

Problem Statement

As of July 2019, 87 countries and territories have reported vector transmission of Zika virus (WHO, 2019). As of January 2018, the reported cases of Zika virus infection worldwide for 2015 through 2017 were 223,477 (PAHO/WHO, 2018). The reported cases in the United Sates and U.S. territories for 2015 were 72 cases, for 2016 were 41,680 cases, for 2017 were 1,118 cases, for 2018 were 222 cases, for 2019 were 102

cases, for 2020 were 61 cases, and for 2021 were 26 cases (CDC, 2021). The rates of disease have had a large decline in both the United States and U.S. territories.

Zika virus infection during pregnancy can lead to serious birth defects including congenital brain, eye, and neurodevelopmental abnormalities (Smoots et al., 2020). From January 1, 2016, to June 30, 2017, there were over 2 million live births, with a rate of birth defects potentially related to Zika virus infection identified as 1.7 per 1,000 live births; this led to a total of 3,359 infants and fetuses with birth defects (Smoots et al., 2020). The mortality rate of microcephaly, a birth defect related to Zika virus infection during pregnancy, is estimated at 8.3% in Brazil (Cunha et al., 2017). There is little to no risk of death due to Zika virus infection when patients do not have microcephaly or other serious conditions impacted by Zika virus (Noor & Ahmed, 2018).

The cost of Zika virus on the healthcare system and society through productivity losses depends largely on the attack rate of the virus (Lee et al., 2017). If the attack rate is 0.01%, the estimated cost is $183.4 million across the six states with the greatest risk of Zika emergence (Alabama, Florida, Georgia, Louisiana, Mississippi, and Texas) (Lee et al., 2017). If the attack rate is 0.025%, 0.10%, or 1%, the estimated cost would be $198.6 million, $274.6 million, or $1.2 billion, respectively (Lee et al., 2017). Preventing Zika virus emergence in the United States could save billions of dollars in healthcare costs and lost productivity (Lee et al., 2017).

To date, research on Zika virus has focused on an individual's knowledge, awareness, risk perceptions, prevention behaviors, intentions to engage in prevention behaviors, risk communication messages, media and communications about Zika virus,

and the public health response to Zika virus outbreaks. There is a gap in understanding about how activities undertaken by health departments impact individual-level knowledge, attitudes, and behaviors. This study addresses one part of that gap by examining the relationship between the health departments' level of engagement in prevention and education, and their communities' risk perceptions.

Purpose of the Study

The purpose of this study was to determine the relationship between prevention and education plans of state-level health departments and the perceived risks of Zika virus infection of the communities within those states. Secondary data regarding health departments' Zika virus prevention and education plans were compared to secondary data regarding the community's perceived risks. The health department Zika virus prevention was measured through survey questions asking about the current level of engagement in vector control to suppress transmission, public health surveillance and epidemiological investigation, and conducting lab testing (NACCHO, 2017a). The health departments' Zika virus education plans were measured through survey questions that gathered information about the current level of engagement providing information to travelers about risks and protection measures, risk communication/community education to inform the public about Zika and related illnesses, and clinician outreach and communication on Zika clinical care guidelines (NACCHO, 2017a). Current research has focused on perceived risks and self-prevention behaviors (Johnson, 2019a; Johnson, 2018; Squiers et al, 2018). This study addresses a gap in the current literature identifying how plans at the health department impact local community perceptions.

Research Questions and Hypothesis

This study addressed the following research questions:

RQ1 - Quantitative: What is the relationship between public health department's level of engagement for prevention of Zika virus infection and the community's perception of risk of contracting the virus?

H_{01} – There is no statistically significant relationship between public health department's level of engagement for prevention of Zika virus infection and the community's perception of risk of contracting the virus.

H_1 – There is a statistically significance relationship between public health department's level of engagement for prevention of Zika virus infection and the community's perception of risk of contracting the virus.

RQ2 – Quantitative: What is the relationship between public health department's level of engagement for community education on Zika virus and the community's perception of risk of contracting the virus?

H_{01} – There is no statistically significant relationship between public health department's level of engagement for community education on Zika virus and the community's perception of risk of contracting the virus.

H_1 – There is a statistically significant relationship between public health department's level of engagement for community education on Zika virus and the community's perception of risk of contracting the virus.

Theoretical Framework

The theoretical framework supporting this study is Rosenstock's (2005) health belief model, which described the emotional and cognitive factors influencing a person's health decisions. These factors include perceived susceptibility, perceived seriousness, perceived barriers, perceived benefits, cues to action, and self-efficacy (Rosenstock, 2005). The detailed explanation of this theoretical framework and factors influencing health behaviors is described in Chapter 2. The health belief model is appropriate for this study because the research questions posed addressed the factors influencing health behaviors. In this study, the local health departments' level of engagement in prevention and education activities has been evaluated as factors that influence the risk perceptions of the communities serviced by the local health departments. The local health departments' plans for education and prevention actions would speak directly to the community's perceived susceptibility, perceived seriousness, perceived barriers, perceived benefits, cues to action, and self-efficacy.

Nature of the Study

This study was a quantitative secondary data analysis, combining two datasets by common independent variable "State." Datasets that were used are the Forces of Change Survey, United States, 2017 (ICPSR 37141) and the RAPID: Assessing the Variance, Effects, and Sources of Aversion to Zika Solutions. The Forces of Change Survey was conducted as a cross-sectional study designed to understand the individual states plans for prevention of infection and education of the public on risk factors for Zika virus (NACCHO, 2017a). The RAPID survey was conducted as a longitudinal study of

individuals risk perceptions and protective actions towards Zika virus (Johnson, 2019a). The risk perceptions of the community were evaluated by public health prevention and education plans at the state-level.

The independent variables were the survey questions from the dataset Forces of Change Survey, which measured the level of engagement for the local health department through education and prevention activities. The first three survey questions below were considered level of engagement in prevention, and the second three survey questions below were considered level of engagement in education. The survey questions asked the respondent to "indicate your LHD's level of engagement (currently or during your most recent mosquito season) in the following activities for Zika prevention and response" (NACCHO, 2017a).

1. Vector control to suppress Zika virus transmission
2. Public health surveillance and epidemiological investigation
3. Conducting and/or coordinating lab testing
4. Providing information to travelers about Zika risks and protection measures
5. Clinician outreach and communication on Zika clinical care guidelines
6. Risk communication/community education to inform the public about Zika virus and related illnesses

The dependent variable was a composite variable of the two survey questions from the dataset RAPID: Assessing the Variance, Effects, and Sources of Aversion to Zika Solutions, which assessed risk perceptions by the community (Johnson, 2019a).

1. How much risk does the Zika virus pose to you or your family?

2. How much risk does the Zika virus pose to the U.S.?

The secondary data was collected by the National Association of County & City Health Officials (2017) and Johnson (2019) using random sampling methods and utilizing online surveys. The two datasets were combined into one using a common variable, reviewed for issues with merging the data, and data analysis performed using SPSS. The details of the data collection methods, sampling, and data analysis plan are described in Chapter 3.

Definitions

Level of Engagement in Prevention Activities: Describes the level of engagement of the local health departments in specific activities designed to prevent Zika virus infection (NACCHO, 2017a).

Level of Engagement in Education Activities: Describes the level of engagement of the local health departments in specific activities designed to educate the public about Zika virus (NACCHO, 2017a).

Local Health Departments (LHDs): Describes the health department as being within the state of interest but local to a region or community (NACCHO, 2017a).

Microcephaly: A birth defect where the head is smaller than normal size; it could mean the brain has not developed properly or stopped developing after birth (CDC, 2019).

Protective behaviors: Actions taken to protect oneself from infection (Daughton & Paul, 2019).

Risk communication: Public health messages designed to communicate the risks of contracting a disease and the prevention methods that can be employed (Allen, 2018).

Risk perception: A person's belief in their likelihood of becoming infected with Zika virus (Guerre-Reyes et al., 2018).

Vector control: Various methods that can be employed to prevent population growth of the disease vector; for Zika virus, these methods control mosquito population growth (Piltch-Loeb et al., 2019).

Zika virus: An arboviral disease caused by the bite of an infected mosquito that can cause birth defects in pregnant women (Noor & Ahmed, 2018).

Assumptions

The purpose of quantitative research is to explain and predict outcomes based on dependent variables (Summer, 2003). The five quantitative paradigm assumptions (ontological, epistemological, axiological, methodological, and rhetorical assumptions) are meaningful to this study (Summer, 2003). For these assumptions to be met, the original researchers conducting the two surveys needed to remain objective and set apart from the research (ontological assumption), which was accomplished by having the surveys conducted in an online format without intervention by the researchers. The epistemological assumption describes the relationship between the researcher and the subject being researched as independent (Summer, 2003). The axiological assumption describes the results of the study being value free and unbiased (Summer, 2003), which is assumed based on the separation of the researchers from their subjects in the two surveys. The methodological assumption describes the research method as a deductive process,

one that is both driven by cause and effect and context free; this also describes the methodological approach as one determined by the data and not assumptions on the part of the researchers (Summer, 2003). The rhetorical assumption describes the language of the research as formal, which is based on set standard definitions and utilizing an impersonal voice to prevent researcher bias from influencing the results (Summer, 2003). This study also assumes generalizability of the results across all populations in the United States to advise public health departments of the importance of their level of engagement in prevention and education plans to the risk perceptions in the communities serviced.

Scope and Delimitations

This study focused on the relationship between local health departments' level of engagement in prevention and education activities, and their community's risk perception of Zika virus infection. These health department activities were chosen as the focus of this study after being identified as lacking from the current literature surrounding factors influencing health behaviors and risk perceptions related to Zika virus infection. Two states in the United States were not represented in the data due to their lack of local health departments: Hawaii and Rhode Island (NACCHO, 2017a). Both datasets were gathered through online survey designs, which leads to some populations being underrepresented in the sampling due to lack of access to the online surveys.

Regardless, the generalizability of the study results should be representative of the overall community perceptions. The states not represented in the study have small enough populations that Hawaii and Rhode Island lack the need for local health departments to support these communities (NACCHO, 2017a). The authors of the

original datasets and studies concluded that their studies were generalizable to the United States population as a whole (Johnson, 2019a; NACCHO, 2017a).

Limitations

A potential limitation to using two secondary data sets is the need to combine these two data sets into one without having quality issues in the combined data set. Access to the secondary data sets could pose a problem if they were not available on the ICPSR open access website in the future. Additionally, the Forces of Change Survey is a restricted level 2 data set, which requires following an application process to be granted access to the data. If the assumptions of the data analysis method, ordered logistic regression, were not met, then there would be limitations to interpreting the study results.

To mitigate the limitations related to study design, method, and data collection, the secondary data sets were evaluated for missing data and data quality issues once combined into one dataset. To test the assumptions for ordered logistic regression, the datasets were reviewed to ensure there were no violations. The large size of the datasets minimizes biases due to data collection; the Forces of Change Survey was conducted using random sampling (NACCHO, 2017a), and the RAPID Survey was conducted using convenience sampling performed by the third-party online survey organization in order to separate the original researchers from the study participants (Johnson, 2019a).

Significance

The results of this study provided insight into the relationship between the prevention and education plans at local health departments and the communities' perceived risk of Zika infection. The positive social change implication of this study is to

provide public health officials with the understanding of how their plans for prevention and education of Zika virus are related to their communities' risk perceptions, which allows for more effective plans to be implemented. The better equipped public health officials are in preventing disease and educating the public, the better equipped the public is at making healthy behavior choices, thus reducing the negative health behaviors, and lowering the risk of infection.

Summary

Zika virus infection rates have been steadily declining in the United States (CDC, 2021), which coincides with a lower level of knowledge and lower perceived risk of infection (Guerre-Reyes et al., 2018; Katler et al., 2017; Winneg et al., 2018). The adverse health outcomes associated with Zika virus infection prompt the need for continued evaluation of the relationships between risk perception and potential factors influencing risk perception (CDC, 2021). The purpose of this study was to examine one such relationship: the relationship between local health departments' level of engagement in prevention and education activities and their community's risk perceptions. Rosenstock's health belief model was used as the theoretical framework to support this study. The assumptions of a quantitative study, assumptions of the data analysis method, and the potential limitations to this study have been addressed. The review of existing literature and detailed theoretical framework that supports this study will be described in Chapter 2.

Chapter 2: Literature Review

Introduction

Zika virus infection rates have remained lower in the United States compared to other countries, contributing to a lower perceived risk of infection by Americans (Guerre-Reyes et al., 2018; Katler et al., 2017; Winneg et al., 2018). Engagement in prevention behaviors is impacted by risk perceptions of infection and the perceived barriers to engaging in those behaviors (Guerre-Reyes et al., 2018; Katler et al., 2017; Winneg et al., 2018). The existing literature addresses the factors influencing behavior decisions, including perceived risk, perceived barriers, perceived benefits, cues to action, self-efficacy, and knowledge of Zika virus transmission, symptoms, and health outcomes. Missing from the existing literature is an assessment of the impact of health departments' level of engagement in education and prevention programs have on their community's risk perceptions. The purpose of this study was to address the identified gap in the existing literature by evaluating the relationship between state health departments' level of engagement in education and prevention plans with their community's risk perceptions.

This chapter will consolidate and summarize the findings from studies related to Zika virus. Literature related to Rosenstock's health belief model with regards to health education will also be reviewed. Finally, this chapter will discuss the methodological approaches used in studies of Zika virus.

Literature Search Strategy

The literature reviewed in this study consisted of topics and central concepts about Zika virus knowledge, risk perceptions, prevention, and response to outbreaks in the United States. The literature search included studies related to awareness and knowledge of Zika virus, community and individual risk perceptions, risk communications about Zika virus, media and communications about Zika virus, prevention methods and willingness to take preventive actions, and public health responses to the Zika virus pandemic. Additional studies reviewed were related to the health belief model and its applications in health education. The literature search was conducted using several databases in the Walden University library, including Thoreau and Health Sciences. The search included only peer reviewed articles published between 2015 and 2021. The studies that were excluded from the literature review were ones that did not address Zika virus in the United States. The articles on the conceptual framework were not related to Zika virus due to limited related studies; however, the articles reviewed were published between 2015 and 2021, except for the work by Rosenstock. The seminal work by Irwin Rosenstock published in 1966 is the framework for this study. A total of 131 articles were obtained and reviewed.

The reviewed studies were summarized and sorted by key words in a literature review matrix. The method, framework, study design, analysis and results, conclusions, and implications for future research and practice were thoroughly reviewed and noted in the literature review matrix. Studies that addressed populations outside the United States were excluded from the literature review. The search terms used were *Zika virus* and

perceived risks, *Zika virus prevention*, *Zika virus* and *risk perception*, *Zika* and *risk perception or perceive risk or harm perception* and *public health or community health or population health*, *health belief model* and *health education* and *U.S. or USA or U.S.A. or United States of America*. These search terms were used in all databases to identify the literature reviewed in this study.

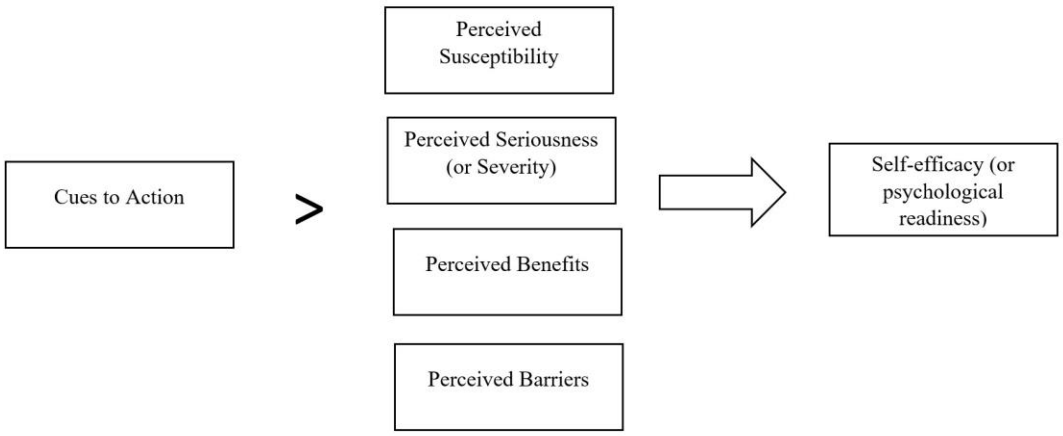
Theoretical Framework

Rosenstock's (2005) health belief model examined the factors influencing an individual's decisions regarding their health. The health belief model (HBM) combines emotional and cognitive factors to explain why people behave the way they do (Rosenstock, 2005). The factors influencing health decisions include perceived susceptibility, perceived seriousness, perceived barriers, perceived benefits, cues to action, and self-efficacy (Rosenstock, 2005). Perceived susceptibility, seriousness, barriers, and benefits refer to a person's beliefs about susceptibility, seriousness, barriers, and benefits (Rosenstock, 2005). Susceptibility refers to the risk of contracting a disease; seriousness refers to the serious or severe consequences of contracting a disease; barriers refer to the inconvenience, expense, unpleasantness, pain, or upsetting nature of taking action to prevent infection; and benefits refer to the gains received by taking action and whether they outweigh the barriers (Rosenstock, 2005). Rosenstock further addresses the cues to action, or factors that prompt individuals to take action to prevent adverse health outcomes, as internal or external to the individual (Rosenstock, 2005). Self-efficacy, or the psychological readiness to take action, is reached when the cues to action trigger an individual to act if the intensity of the cue was strong enough to overcome the

individual's beliefs about susceptibility, seriousness, barriers, and benefits (Rosenstock, 2005).

Figure 1

Health Belief Model



Note: Health Belief diagram adapted from "Why people use health services" by I. M. Rosenstock, 2005, *The Milbank Quarterly*, 83(4).

Utilizing the HBM in survey construction allows researchers and public health officials to gauge the community's levels of knowledge about disease and prevention, perceived barriers, benefits, severity, and self-efficacy (Guilford et al., 2017; Zare et al., 2015). Guilford and colleagues (2017) used the Breast Cancer Knowledge Test and the Revised Susceptibility, Benefits, and Barriers Scale for Mammography Screening to evaluate the knowledge, beliefs, and screening behaviors of college women. The prevention behavior of breast self-examination was seen in individuals who had low perceived barriers and high self-efficacy scores (Guilford et al., 2017). A health education program can be developed based on the HBM principles to improve knowledge and awareness of breast cancer (Guilford et al., 2017). Luquis and Kensinger (2019)

assessed young adults' perceptions of susceptibility, severity, and access to preventive services. Perceptions of severity and susceptibility impacted an individual's decision to engage preventive services; leading to the conclusion that health education programs should utilize the HBM principles to increase the use of preventive services (Luquis & Kensinger, 2019). Marcell and Spurlock (2020) surveyed students, utilizing HBM principles in the construction of their survey questions to determine the beliefs, perceived susceptibility, perceived barriers, and intentions towards the flu vaccine. Overall, perceived susceptibility and perceived barriers were low, indicating perceived barriers were not impacting the decision to vaccinate (Marcell & Spurlock, 2020). Grace-Leitch and Shneyderman (2016) examined HPV knowledge and self-efficacy using HBM principles and determined that perceived susceptibility and self-efficacy were predictors of positive prevention uptake. Health education programs based on HBM principles can lead to improved self-efficacy, perceived susceptibility, barriers, benefits, and knowledge of disease.

As a framework, the health belief model has been used in applications of health education and to explain health behaviors, individual motivations for taking action, and individual decision-making processes (Ayaz-Alkaya et al., 2019; Lein et al., 2016; Sundstrom et al., 2018; Zare et al., 2015). The health belief model is an appropriate framework for this study as it focuses on the factors impacting perceived risks of Zika virus infection, specifically the state level health departments' plans for prevention and education plans in response to Zika virus outbreaks. Perceived risk is one of the factors

noted in Rosenstock's health belief model as influencing health behaviors (Rosenstock, 2005).

Ayaz-Alkaya and colleagues (2019) applied the HBM to an education program to help adolescents cope with pre-menstrual syndrome (PMS) symptoms. The program increased awareness of PMS symptoms and techniques for combatting them, which led to fewer PMS symptoms compared to the control group (Ayaz-Alkaya et al., 2019). Similarly, Zare and colleagues (2015) found an improvement in mean scores for perceived barriers, perceived susceptibility, perceived benefits, perceived severity, and knowledge level in participants after they attended training workshops developed with the HBM principles. Similarly, Lein and colleagues (2016) noted a decrease in perceived barriers and an increase in perceived susceptibility and severity after participants attended a health education program based on the HBM principles. There was an increased uptake in prevention behaviors, including improved calcium use and vitamin D use, after implementation of the educational program (Lein et al., 2016).

Sundstrom and colleagues (2018) evaluated effectiveness at improving perceived susceptibility, benefits, and barriers of HPV prevention for the Cervical Cancer-Free South Carolina program "It's My Time," which included community-based participatory research and HBM principles (Sundstrom et al., 2018). The education campaign increased perceptions of susceptibility, decreased perceived barriers, increased perceived benefits, and increased uptake of prevention behavior through the HPV vaccine (Sundstrom et al., 2018). Additionally, Nguyen-Truong and colleagues (2017) utilized HBM principles in the creation of an education program aimed to improve perceived

susceptibility, benefits, and barriers of mammography screening for breast cancer prevention. The education program increased knowledge about breast cancer, perceived susceptibility, benefits, and mammography screening rates among participants (Nguyen-Truong et al., 2017).

In agreement with the findings above, Onyegbule and colleagues (2021) saw an improvement in preventive behavior uptake as the result of an educational program based on HBM principles. Study participants were educated on healthy eating and physical activities to promote weight loss, which led to improved nutrition knowledge, improved exercise knowledge, and significant weight loss by participants (Onyegbule et al., 2021). Additional studies support the use of HBM principles in developing health education programs to target improved engagement in healthy behaviors (Matin et al., 2020). An educational program was developed to teach pregnant women proper exercise techniques during their pregnancies, leading to improved exercised levels, perceived severity, perceived benefits, and cues to action (Matin et al., 2020).

Johnson (2018) explored the effects of residential location and psychological distance on an individual's views and behavioral intentions using the health belief model framework. The residential location and psychological distance perceived by the individuals impacted their risk perceptions of Zika virus infection, and therefore, their behavioral intentions (Johnson, 2018). Sridhar and colleagues (2016) conducted a systematic review of studies measuring traveler's risk perceptions of infectious diseases using the HBM framework for describing the perceived barriers and benefits. Healthy

behaviors were predicted by low perceived barriers and high perceived benefits in 18 of the articles included in the meta-analysis (Sridhar et al., 2016).

This study will build upon the existing literature by examining the impact of local health departments' level of engagement in plans for prevention and education on the community's perceived risk of infection of the Zika virus. The existing literature fails to investigate the relationship between health departments' level of engagement in plans for prevention and education, and the risk perceptions of their communities, as they relate to Zika virus. Several studies addressed the variables in this study and supported the gap found in the literature (Guerra-Reyes et al., 2018; Johnson, 2019b; Johnson, 2018; Squiers et al., 2018). Guerra-Reyes and colleagues (2018) examined the knowledge of Zika virus transmission and perceived risk, whereas Squiers and colleagues (2018) examined knowledge, perceived risk, and prevention behavior intentions of U.S. travelers. Both studies identified a lack of knowledge for sexual transmission of Zika virus, perceived risks, and intentions to engage in prevention behaviors were impacted by location (Guerra-Reyes et al., 2018; Squiers et al., 2018). Johnson (2019b) determined that exposure to health education information impacted perceived risk and intentions to engage in preventive behaviors were influenced by perceived barriers. Further, McDonald and colleagues (2018) identified a positive relationship between health education and practicing prevention behaviors against Zika virus. To address the identified gap in the existing literature, this study examined the relationship between public health departments' levels of engagement for prevention and education of Zika virus infection, considering the community's risk perception of contracting the virus.

Literature Review Related to Key Variables

Risk Perceptions of the Zika Virus

Zika virus risk perceptions have been shown to impact an individual's response to disease outbreaks; leading to the need to evaluate an individual's knowledge of Zika virus transmission routes, symptoms and health outcomes. Awareness of Zika virus did not equate to high levels or accuracy of knowledge about transmission routes, symptoms, or health outcomes in several studies that investigated the relationship between awareness and/or knowledge and risk perceptions (Guerre-Reyes et al., 2018; Katler et al., 2017; Winneg et al., 2018). Guerra-Reyes and colleagues (2018) determined that a low response rate of sexual transmission as a possible infection route led to a lower perceived risk of infection through sexual transmission.

Protective behaviors include seeking testing for Zika virus, using mosquito repellent, wearing protective clothing, using bed nets, removing mosquito breeding and nesting sites, etc. These protective health behaviors were impacted by risk perceptions in several studies (Daughton & Paul, 2019; Moise et al., 2018). Daughton and Paul (2019) determined that exposure to Zika information online increased likelihood of changing travel plans and increased risk perception led to a change in travel plans. Risk perceptions were tied to geographic location in the United States and pregnancy, with pregnancy and residence in high-risk regions increasing risk perceptions (Daughton & Paul, 2019). In a study by Moise and colleagues (2018), knowing someone who was pregnant and higher Zika knowledge was positively associated with protective health behaviors. Moore and colleagues (2019) found that higher risk perceptions were more predictive of testing

behaviors than having a lack of barriers or a high level of Zika related knowledge; which was consistent with the findings from the studies by Daughton and Paul (2019) and Moise and colleagues (2018).

Several studies have determined a difference in risk perceptions based on community risk versus personal risk (Chandrasekaran et al., 2017; Johnson, 2018; Reynolds et al., 2019). Reynolds and colleagues (2019) determined that 13% of U.S. adults perceived Zika infection as a major threat to their personal health, while 60% perceived Zika infection to be a major threat to pregnant women in the United States. In the study conducted by Chandrasekaran and colleagues (2017) participants perceived a higher community risk of Zika infection than personal risk; with 92.6% responding that Zika was an important issue and 26.9% indicating a belief that they could get infected in their location. Personal risk perceptions of Zika virus infection played an important role in determining the need to engage in preventive behaviors (Reynolds et al., 2019). Individuals had low personal perceived risk, 13% indicated Zika was a major threat to personal health and 38% indicated no personal threat at all (Reynolds et al., 2019). Personal risk views and intentions to practice prevention behaviors were enhanced by hazard proximity, or the distance from high-risk areas (Johnson, 2018). Social and geographical distance from high-risk areas decreased personal risk views and intentions to practice prevention behaviors (Johnson, 2018). Public health advisories impacted individual perceptions of preparedness, but not their personal risk perceptions (Avery et al., 2020). Avery and colleagues (2020) evaluated crisis self–efficacy as a predictor of

individual's perceptions of risk and preparedness. Individuals with higher crisis self-efficacy showed a higher perception of preparedness (Avery et al., 2020).

When individuals related risky situations to themselves and their communities, they tended to be more motivated to find information about the disease (Lee et al., 2020). The motivation seen that explained information seeking behaviors was to effectively prepare for the potential consequences of novel viruses and cope with uncertainties of disease (Lee et al., 2020). Personal and community risk association led to higher engagement in preventive behaviors (Lee et al., 2020).

Zika Virus Knowledge and Awareness

Awareness of Zika virus did not equate to accurate knowledge of Zika virus symptoms, transmission routes, and treatment. Health care providers were a resource of Zika virus knowledge during the pandemic; but were limited by their own knowledge and education on Zika virus transmission, symptoms, and preventive behaviors (Moore, 2016; Plaster et al., 2018). Plaster and colleagues (2018) interviewed college students to determine the difference between health and non-health majors in knowledge, attitudes, and information seeking behaviors. Health majors were significantly more knowledgeable about Zika than non-health majors; both groups showed substantial limitations in knowledge regarding sexual transmission, Zika causing Guillain-Barré syndrome, and Zika as a health threat for pregnant women in the United States (Plaster et al., 2018). Students enrolled in a physician assistant program participated in a survey to determine their knowledge levels related to Zika virus (Wishner et al., 2020). Wishner and colleagues (2020) determined that future physician assistants had gaps in their

knowledge of Zika virus transmission routes, screening of pregnant patients, symptoms of infection, and treatment options. Moore (2016) conducted a survey of Nurse Practitioners (NP) at a National Nurse Practitioner conference and determined there was a significant lack of knowledge about Zika virus. The average overall knowledge score for NPs was 58%, which highlighted a lack of healthcare provider knowledge to pass onto patients, which could have led to a lack of knowledge on transmission routes and prevention behaviors (Moore, 2016). Healthcare providers, such as nurse practitioners, were ideal candidates for the surveillance and education of patients and the community (McNeill et al., 2016). Lower levels of knowledge found in health care providers could have led to low levels of knowledge and engagement in prevention behaviors within the community.

Residents from high-risk areas showed higher levels of Zika virus knowledge, which led to higher levels of perceived risk across multiple studies (Johnson, 2018; Reynolds et al., 2019; Squiers et al., 2018; Winneg et al., 2018). Winneg and colleagues (2018) investigated whether Zika-related knowledge, attitudes, and prevention behaviors differed based on residence located in Florida versus the rest of the country. Floridians demonstrated higher levels of knowledge, more positive attitude towards prevention behaviors, and a higher likelihood of engaging in preventive behaviors than non-Floridians (Winneg et al., 2018). Reynolds and colleagues (2019) determined that a low-risk perception at the personal level led to low engagement in protective behaviors. Squiers and colleagues (2018) investigated the relationship between residence located in Puerto Rico, high risk states within the United States, and other states in the United States

and levels of knowledge, perceived risk, and intentions toward prevention behaviors. Overall, residents of Puerto Rico demonstrated higher levels of knowledge than high-risk states and other states in the United States (Squiers et al., 2018). Additionally, residents in Puerto Rico were more likely to have high intentions of practicing preventive behaviors than the other two regions (Squiers et al., 2018). Across all three regions, knowledge of post-travel precautions was low, leading to low uptake of prevention behaviors for those participants who had recently travelled (Squiers et al., 2018). Overall, residency location contributed to feelings of high perceived risk in addition to high levels of knowledge of Zika virus transmission (Johnson, 2018; Reynolds et al., 2019; Squiers et al., 2018; Winneg et al., 2018).

In contrast to the findings from the studies by Winneg and colleagues (2018), Reynolds and colleagues (2019), and Squiers and colleagues (2018); Pogreba-Brown and colleagues (2020) determined that residents in Arizona, a high-risk state, had a lower perceived risk of Zika virus due to higher concerns over other health conditions impacting their state. In a statewide online survey of Arizona residents, low knowledge of mosquito-borne diseases was reported in conjunction with low levels of prevention of mosquito-borne diseases (Pogreba-Brown et al., 2020). The participants of the study conducted by Pogreba-Brown and colleagues (2020) indicated greater concern over chronic health conditions than infectious diseases; but showed a high level of willingness to engage in community cleanup efforts if it would reduce the number of mosquitos near their homes (Pogreba-Brown et al., 2020). However, one in eight participants reported a lack of removing standing water to reduce mosquitoes, while stating it was known to be

an effective method for preventing mosquitos; and willingness to engage in prevention behaviors increased if residing in an area with confirmed disease (Pogreba-Brown et al., 2020).

Increased media coverage was associated with higher knowledge of Zika virus (Ophir & Jamieson, 2020). Total amount of media coverage was compared to knowledge of Zika virus in a study by Ophir and Jamieson (2020), which determined that the amount of coverage was associated with an increase in knowledge the following day. Additionally, the content of media coverage changed over time, with certain knowledge peaking around the Rio Olympic Games, the CDC announcement, and the Senate vote on Zika funding (Ophir & Jamieson, 2020). Knowledge of mosquito transmission was higher than the health outcome of microcephaly, less knowledge of sexual transmission, and least amount of knowledge on asymptomatic nature of infection (Ophir & Jamieson, 2020).

Knowledge of Zika virus changed over time as new information became available and media covered different aspects of the disease (Katler et al., 2017). Katler and colleagues (2017) conducted a study of two time periods to determine the awareness of Zika virus symptoms, transmission, and treatment changes between healthcare providers and community members. Increased knowledge of Zika virus, symptoms, and recent outbreaks from 2016 to 2017 time points were seen (Katler et al., 2017). There were differences seen between healthcare provider knowledge and community knowledge between the two time points; with healthcare provider knowledge showing no change with regards to microcephaly and community knowledge increasing (Katler et al., 2017).

Community member knowledge improved for prevention behaviors leading to increased use of prevention behaviors reported (Katler et al., 2017).

Awareness of Zika virus did not equate to high levels of knowledge of prevention behaviors or to the successful implementation of preventive actions (Guerra-Reyes et al., 2018; Zhou-Talbert et al., 2020). In the study conducted by Zhou-Talbert and colleagues (2020) there was no difference in awareness between pregnant participants and non-pregnant participants; however, knowledge of Zika virus and preventive actions was low. Knowledge of Zika virus transmission routes and symptoms was moderate to high, but knowledge of how to prevent sexual transmission and congenital transmission was low (Zhou-Talbert et al., 2020). The participants indicated a high willingness to engage in preventive actions but had low knowledge of these actions (Zhou-Talbert et al., 2020). Guerra-Reyes and colleagues (2018) examined sexually active adults in the United States to determine the level of knowledge of Zika transmission and risk perceptions. Perceived risk of Zika virus infection was reported as no risk or low in 90% of participants; with slightly higher perceived risk reported in higher risk areas of the United States (Guerra-Reyes et al., 2018). Transmission by mosquito bite was identified correctly by most of the participants, with sexual transmission and vertical transmission identified by less than half the participants (Guerra-Reyes et al., 2018).

Several studies showed a relationship between engaging in preventive behaviors and high levels of knowledge of transmission routes (Nelson et al., 2019; Patel et al., 2019; Piltch-Loeb et al., 2019). Travelers from the United States with higher levels of knowledge of Zika transmissibility were 1.55 times more likely to take preventive

actions, including condom use and abstinence (Nelson et al., 2019). Patel and colleagues (2019) found a high level of knowledge of Zika virus among Latinas of childbearing age living in South Florida. The participants who scored high knowledge of Zika virus transmission were 5.86 times more likely to report taking good preventive measures compared to those without knowledge of Zika virus transmission (Patel et al., 2019). In 2016, a sample of U.S. residents participated in a study to determine knowledge of Zika virus transmission prior to domestic transmission of disease; 78% of participants were aware of Zika virus (Piltch-Loeb et al., 2017). Public support of vector control activities and prevention behaviors depended on perceived risk, knowledge of disease characteristics, and confidence in the government to provide proper prevention procedures (Piltch-Loeb et al., 2019).

Amongst high-risk populations, pregnant women and women who might become pregnant have shown higher levels of knowledge of Zika virus transmission when compared to the overall population; however, prevention method knowledge remains low (McDonald et al., 2018; Prue et al., 2017). McDonald and colleagues (2018) investigated the level of knowledge of pregnant women and women at risk of becoming pregnant in the high-risk U.S.-Mexico border region while addressing sources of information that could close the gaps in knowledge identified. Of these participants, 69.5% correctly identified two transmission routes for Zika virus and 16.1% correctly identified condom use as a prevention method (McDonald et al., 2018). A gap in knowledge was identified pertaining to correct prevention methods with 9.5% of women reporting the information they gained from television or radio reporting as helpful (McDonald et al., 2018). This

gap was seen as a lack of knowledge around prevention methods and led to a lower uptake of prevention methods (McDonald et al., 2018). Prue and colleagues (2017) investigated the knowledge and prevention behaviors of pregnant women compared to the overall community and determined that pregnant women engaged in more preventive behaviors than the community. Participants in the study identified the cause and consequences of Zika virus accurately but had limited knowledge of prevention methods, which was reported to be a lesser focus of the health messages received by the participants (Prue et al., 2017).

A lack of confidence in effectiveness of prevention behaviors has led to low engagement in these behaviors (Darrow et al., 2018). In a study conducted by Darrow and colleagues (2018), university students in Miami participated in a survey to determine their knowledge of Zika virus; 99.3% of the students were aware of Zika virus. Sixty-six percent of participants were sure Zika virus could be prevented but indicated a lack of confidence in whether the preventions methods were effective at preventing Zika virus transmission (Darrow et al., 2018).

Zika Virus and Behavior Change

Behavior change related to Zika virus was determined by several factors, including proximity to outbreak areas, knowledge of Zika virus, and risk perceptions. Thompson and colleagues (2018) investigated the motivating factors that would impact the decision for college women in Florida to change their birth control methods in response to Zika virus outbreaks. Twenty-seven percent of women reported a willingness to change birth control method if residing in an area with active Zika infections

(Thompson et al., 2018). Factors that impacted the women's willingness to change birth control method were identified as knowledge of sexual transmission and fear of being infected (Thompson et al., 2018).

Painter and colleagues (2017) found that participants were less likely to be vaccinated if they had reported that they believed Zika virus was not a big problem. There was a positive association between desiring a Zika virus vaccine and higher levels of knowledge about Zika virus, higher perceived susceptibility, and a higher perceived severity for women and children (Ophir & Jamieson, 2018; Painter et al., 2017). Additionally, there was a significant relationship between knowing where to look for Zika-related information and actively seeking Zika information and desire to be vaccinated (Painter et al., 2017). Participants had low personal perceived risk, 13% indicated Zika was a major threat to personal health and 38% indicated no personal threat at all (Reynolds et al., 2019). Due to the perception of low personal risk, Reynolds and colleagues observed low participation in prevention behaviors reported in the survey; 15% of participants indicated they engaged in preventive behaviors (Reynolds et al., 2019). In a study of pregnant or recently pregnant women, three main factors were found to influence the decision to receive a Zika virus vaccine; evidence, risk, and trust (Jaffe et al., 2020). Jaffe and colleagues (2020) determined that the evidence around vaccine safety, namely whether the vaccine was proven safe in pregnant animals and non-pregnant humans affected willingness to become vaccinated. When considering risks of the vaccine, the participants were concerned over harm to the fetus or baby and not concerned over risks to self (Jaffe et al., 2020).

Trust in vaccines, research, and the medical community along with factors that impact one's trust in vaccines, research and the medical community were noted as the factors examined during the conversation about trust (Jaffe et al., 2020; Ophir & Jamieson, 2018). Jaffe and colleagues (2020) determined that gaps in vaccine evidence, by exclusion of pregnant women from drug and vaccine trials, led to less willingness to be vaccinated. The gaps in evidence impacted the risk perceptions of being vaccinated, but were somewhat mitigated by trust in personal physician's when seeking advice on becoming vaccinated (Jaffe et al., 2020). Vielot and colleagues (2018) evaluated the concern of infection while travelling and willingness to be vaccinated; about half of the participants were willing to receive the vaccine regardless of travel destination. Factors that influenced the decision to become vaccinated were Hispanic ethnicity, discussing Zika virus with a medical professional, risk perceptions of Zika virus infection, and self-efficacy for Zika virus prevention (Vielot et al., 2018). Concern over Zika virus infection was found to be a predictor of willingness to become vaccinated (Vielot et al., 2018). Ophir and Jamieson (2018) found that misbelief about the measles, mumps, and rubella (MMR) vaccine causing neurological disorders including autism was the strongest predictor of participant's willingness to be vaccinated for Zika virus.

Chan, Farhadloo, and colleagues (2018) reported a change in behavior seen when evaluating households with pregnant or intending to become pregnant family members and other households, which was consistent with the findings from Painter and colleagues (2017). Households with pregnant or intending to become pregnant women were more likely to report travel plan changes as a result of seeking Zika virus information online

(Chan, Farhadloo et al., 2018). In a study by Chan, Farhadloo, and colleagues (2018), information seeking behaviors influenced knowledge of Zika virus and preventive behaviors, specifically when information was discussed with healthcare practitioners or family and friends. Households with pregnant or intending to become pregnant family members and other households reported inadequate knowledge about the asymptomatic nature of Zika virus infections (Chan, Farhadloo et al., 2018).

Of the participants that were aware of Zika virus (78% of participants), more than half indicated they would delay pregnancy for a year or more based on public health warnings and 1/3 of participants agreed with vector-control prevention plans for indoor spraying (Piltch-Loeb et al., 2017). Among these participants, 2/3 agreed that the government should make pregnancy termination available to any women who learned their fetuses had Zika-related birth defects (Piltch-Loeb et al., 2017).

Findings by Chan, Farhadloo, and colleagues (2018) and Painter and colleagues (2017) were aligned with respect to high-risk perception leading to behavior change. In support of these results, Thompson and colleagues (2018) and Piltch-Loeb and colleagues (2017) determined that high risk perception and high levels of knowledge led to behavior change related to preventing infection.

Zika Virus Prevention

Taking action to prevent Zika virus transmission was determined by several factors, including knowledge and awareness of Zika virus, perceived barriers to prevention behaviors, perceived risk of infection, and trust in prevention methods. Lack of awareness of Zika virus led to a lack of prevention behavior engagement in the U.S.

Virgin Islands (Voelker, 2017). Awareness of Zika virus information was low among pregnant women and the community members surveyed (Voelker, 2017). Thirty-five percent of pregnant women and 49% of community members knew Zika virus was transmitted by mosquitos, 4% of pregnant women and 10% of community members were aware of transmission on the islands, and less than 3% of all participants were aware of personal prevention practices (Voelker, 2017). Hills and colleagues (2016) identified sexual transmission as being more widespread than previously reported. The case study highlighted the need for education on condom use to prevent infection, especially for pregnant women as the adverse health outcomes due to Zika virus infection included birth defects and fetal death (Hills et al., 2016).

Howells and colleagues (2018) identified socioeconomic and infrastructure barriers to engaging in prevention behaviors. The participants of the study, adults from American Samoan public health clinics, had high levels of knowledge surrounding mosquito prevention methods, but were unable to engage in these methods due to barriers (Howells et al., 2018). Logistic and belief-based barriers to prenatal care led to care sought or received later in pregnancy and had the highest impact on unmarried and lower-income women (Howells et al., 2018). Prevention of unintended pregnancies would prevent many Zika-related microcephaly births in the United States (Ahrens et al., 2017). Ahrens and colleagues (2017) determined that enhanced access to contraceptive methods would decrease the predicted Zika-related microcephaly birth rates by 16%. Additionally, a combined effort of enhanced access to contraceptive methods and the Zika vaccine would reduce the Zika-related microcephaly birth rates by 54% (Ahrens et al., 2017).

Berenson and colleagues (2017) found that women born in Zika virus outbreak areas had higher levels of knowledge than those born in the United States. As a result, these women were also more likely to indicate they would be interested in receiving a Zika virus vaccine in the future (Berenson et al., 2017). Additionally, women born in outbreak areas were more likely to have heard of Zika virus, have discussed with their doctors the risks of travelling to outbreak areas, be concerned about using mosquito repellent while pregnant, know that the most common birth defect reported was microcephaly, and were more likely to report trusting their family and friends for Zika virus information than their healthcare providers (Berenson et al., 2017). Women born in outbreak areas reported less desire to keep their Zika virus infection status and their family's status a secret from others (Berenson et al., 2017). Heitzinger and colleagues (2018) conducted a survey of women of childbearing age who tested negative for Zika virus in Kentucky and determined that 56% of women were aware that Zika could be transmitted sexually. Twenty-two percent of women reported condom use or abstinence as a prevention method and 64% of women reported taking preventive actions (Heitzinger et al., 2018). Heitzinger and colleagues (2018) concluded that the women in their survey were more knowledgeable about Zika virus, but still had low knowledge of sexual transmission of Zika virus and therefore low uptake of prevention of Zika virus sexual transmission.

Individuals who had previous exposure to Zika virus knowledge and prevention methods and were offered low cost or free access to prevention methods were more likely to engage in prevention behaviors (Avery et al., 2020; Juarez et al., 2021). Juarez and

colleagues (2021) found that households that were involved in a weekly mosquito surveillance program had high knowledge of mosquitos, 90% able to recognize adult mosquitos and at least one arboviral disease, and 85% of respondents had heard of Zika virus. Cost and responsibility of prevention methods impacted the household's willingness to practice these methods (Juarez et al., 2021). Ninety-five percent of respondents indicated they would support the use of Autocidal Gravid Ovitrap (AGO) if the traps and maintenance were free (Juarez et al., 2021). Avery and colleagues (2020) determined that there were underlying factors impacting an individual's decisions to follow public health guidelines. The factors identified included cost, vulnerability of crisis, proximity of the crisis, ease of following directives, state health department advisories, and federal agency advisories (Avery et al., 2020). Socioeconomic status was shown to be inversely related to risk perception and preventive actions against Zika virus (Lo & Laurent-Simpson, 2018). Risk perception was identified as a mediator in the relationship between preventive actions and socioeconomic status, sociodemographic, and Zika-related variables (Lo & Laurent-Simpson, 2018). Participants with higher socioeconomic status and higher education reported Zika virus infection risk as low, and in turn had lower preventive actions taken (Lo & Laurent-Simpson, 2018). Participants that reported low risk perceptions also reported fewer preventive actions taken against Zika virus infection (Lo & Laurent-Simpson, 2018). Overall, female participants had higher risk perceptions and higher uptake of preventive actions than male participants (Lo & Laurent-Simpson, 2018).

With public health crises such as the Zika virus pandemic different public health campaigns were developed to reach the audiences from the broadest populations to the highest risk populations to engage them in education and prevention behaviors. The type of public health campaign influenced the engagement in prevention behaviors across several studies (Earle-Richardson et al., 2018; Juarbe-Rey et al., 2018; Moore, 2016). Earle-Richardson and colleagues (2018) assessed the influence of pregnant women's prevention behaviors across four public health interventions rolled out in Puerto Rico. The four interventions included the Puerto Rico Department of Health (PRDOH) Women, Infants, and Children (WIC) Program Zika Orientation, Zika Prevention Kit distribution, Detén el Zika Campaign (message campaign using television, print, radio, and social media to educate on prevention methods), and an offer of free residential mosquito spraying services (Earle-Richardson et al., 2018). Fifty-one percent of participants reported exposure to the Detén el Zika Campaign, 93% to the PRDOH WIC Zika Orientation Program, 75% participated in the Zika Prevention Kit distribution, and 68% had exposure to the free residential mosquito spraying services (Earle-Richardson et al., 2018). A strong association was found between the offer of free residential mosquito spraying services and engaging in indoor spraying (Earle-Richardson et al., 2018). A significant association was found between Zika Prevention Kit receipt and reported engagement in larvicide application and bed net use prevention methods (Earle-Richardson et al., 2018). Ninety percent of women reported removing standing water and most reported the use of mosquito repellent as a frequent means to prevent Zika infection (Earle-Richardson et al., 2018). Individuals who relied on healthcare providers to educate

them of their risks and prevention actions might have encountered a low level of knowledge amongst their providers (Moore, 2016). Participants were in agreement that risk communications needed to encourage adoption of behavioral, environmental, and clinical interventions for the prevention of Zika virus transmission (Piltch-Loeb et al., 2017). Participants that identified confidence in the government were more likely to support prevention interventions (Piltch-Loeb et al., 2019).

Vector control methods have been investigated as a means to prevent transmission of Zika virus and other arboviruses transmitted by the *Aedes aegypti* mosquitos (Calder, 2017; Callender, 2018; Seidlein et al., 2017). The *Aedes aegypti* mosquito was once eradicated from Brazil, where it now has a strong endemic hold and is responsible for the transmission of several arboviruses, including Zika virus (Callender, 2018). The vector control methods include infecting mosquitos with a bacterium, sterilizing male mosquitos, releasing engineered mosquitos, and using female mosquitos as carries for synthetic juvenile hormone (Calder, 2017; Seidlein et al., 2017). Infecting *Aedes aegypti* mosquitos with a strain of *Wolbachia* bacteria could prevent the transmission of Zika, Dengue, and Chikungunya (Seidlein et al., 2017). Another method using the Wolbachia bacteria introduces a strain into male mosquitos that causes eggs to become sterile after mating (Seidlein et al., 2017). The release of large numbers of sterile males into the wild populations of mosquitos could lead to reduced populations as seen in the techniques used to prevent *Cochliomyia homuinivorax* and *Glossina austeni tsetse* flies (Seidlein et al., 2017). Engineered mosquitos can be developed that carry a lethal gene that would cause the death of the engineered males' offspring due to an absence of tetracycline in

local water and repression of tetracycline in the offspring (Seidlein et al., 2017). Finally, the method of using female mosquitos as carriers of synthetic juvenile hormone, pyriproxyfen to larval sites happened through the use of a powder laced black cloth that the mosquitos see as a possible oviposition site (Seidlein et al., 2017).

Engineered or genetically modified mosquitos show the most promise for large scale success at reducing or eliminating mosquito populations and have a history of being responsible for the complete eradication of *Aedes aegypti* in Panama during the creation of the Panama Canal (Calder, 2017; Callender, 2018). Adalja and colleagues (2016) surveyed residents of a neighborhood in Key West, Florida to understand the resident's opinions of genetically modified mosquitos as a method to control the mosquito population. Residents who reported mosquitos as a nuisance in their neighborhood or had higher risk perceptions of contracting a mosquito transmitted disease were more likely to support genetically modified mosquitos (Adalja et al., 2016). Overall, 58% of the residents opposed or strongly opposed the use of genetically modified mosquitos as a population control method; residents were concerned with the safety of genetically modified mosquitos, with the impacts of introducing genetically modified mosquitos into the ecosystem, and that using genetically modified mosquitos would open the way for other genetically modified organisms in their community (Adalja et al., 2016).

Confidence levels in local government and health departments impacted prevention method uptake in several populations, including women in Brazil, Puerto Rico, and the United States (Linde-Arias et al., 2020; Piltch-Loeb et al., 2019). Distrust or adversarial relationships with the local government or health departments has led to a

lack of confidence in public health messages surrounding prevention behaviors (Linde-Arias et al., 2020). This situation has been compounded by the government and health department placing the responsibility of prevention on the populations they serve, leading to frustration and unwillingness or inability to follow prevention guidelines (Linde-Arias et al., 2020). On the reverse we have seen that confidence in government to respond to Zika virus was a predictor of support for prevention interventions (Piltch-Loeb et al., 2019). The prevention methods that were supported were indoor spraying at 78.5%, outdoor spraying at 39.8%, and larvicide tablet use at 65.8% (Piltch-Loeb et al., 2019). Additionally, higher levels of knowledge of Zika virus were associated with an increased likelihood of supporting indoor and outdoor spraying as a prevention method (Piltch-Loeb et al., 2019). Respect of scientific authority influenced the populations approval rate for genetic engineering techniques to combat Zika virus transmission through mosquito prevention (Lull et al., 2020). Specifically, participants who reported respect for scientific authority had a positive association with genetically engineered food and genetically engineered mosquito benefit perceptions (Lull et al., 2020). Meaning they approved the use of genetically engineered food and reported higher levels of benefit seen with the use of genetically engineered food in the prevention of mosquitos (Lull et al., 2020). In agreement with Piltch-Loeb and colleagues (2019), Lull and colleagues (2020), and Vos and colleagues (2018) found that risk messages posted to Twitter by federal agencies were shared 106% more often than messages posted from other accounts. Unlike the findings from Linde-Arias and colleagues (2020), these other studies suggest federal

health agencies' messages are trusted more than other organizations or users' messages (Lull et al., 2020; Piltch-Loeb et al., 2019; Vos et al., 2018).

Risk Communication for Zika Virus

Proper communication of the risks of Zika virus was important for increasing the community's knowledge of the disease and prevention behaviors. Risk communication messages can take on different forms based on the communication method, but also need to factor in the social constructs of the audience to be most impactful. Communicating risk to the community was challenging during the Zika virus pandemic due to the rapidly changing information (Allen, 2018). There was a need to educate the public about the adverse health outcomes of Zika virus and prevention methods that should be followed; however, framing these risk messages was complicated by frequently changing scientific information, due to continued research to combat the pandemic, and the variety of communication sources needed to reach the broadest populations to make the most impact (Allen, 2018). Risk communication strategies that included Community Based Participatory Research (CBPR) in the design phase improved engagement in prevention behaviors and increased knowledge of Zika virus prevention behaviors (Juarbe-Rey et al., 2018; Toppenberg-Pejcic et al., 2019). Personal responsibility for engaging in prevention activities increased from 60% of participants acknowledging personal responsibility before CBPR to 85.3% acknowledging personal responsibility after CBPR engagement in risk communication strategies (Juarbe-Rey et al., 2018). The involvement of community and faith-based organizations (CFBOs) in the development of risk communications and public health messages has been effective in public acceptance (Santibañez et al., 2017;

Toppenberg-Pejcic et al., 2019). CFBOs assisted public health officials with developing risk communications and messages designed to be relatable to the community through their experiences, expectations, culture, and context (Santibañez et al., 2017; Allen, 2018). CFBOs helped tailor messages to populations within the community that most needed to receive the information and advice on communication methods that would work best for reaching these populations (Santibañez et al., 2017; Toppenberg-Pejcic et al., 2019).

Toppenberg-Pejcic and colleagues (2019) performed a rapid review of gray literature (literature not controlled by commercial publishers) between 2015 and 2016 to identify best practices for risk communications and improved community uptake of messages. Early communication planning and engagement of community leaders has been shown to improve risk communication message uptake (Toppenberg-Pejcic et al., 2019). Community engagement was found to rely heavily on trust in the risk messages, which was improved by engaging local leaders, tailoring messages based on cultural beliefs, gender, language, local circumstances, community history, and political climate (Allen, 2018; Toppenberg-Pejcic, et al., 2019). The distribution method of the risk communications was impacted by the specific community; some communities favored radio broadcasts, religious gatherings, and house-to-house visits (Toppenberg-Pejcic et al., 2019). Social media platforms were acknowledged as a source of information, even though at the time of the study it was seen more frequently in large urban areas and less frequently in rural areas (Toppenberg-Pejcic et al., 2019).

Vos and colleagues (2018) analyzed Twitter messages posted to health and government agency sites to determine the impact of threat and efficacy information on the sharing of risk messages. Risk messages that included images were shared 70% more often than messages without images, messages that included #Zika were shared 52% more often than without, messages with severity information were shared 102% more than without, and messages containing efficacy information were shared 33% more often than without (Vos et al., 2018). Severity and efficacy used in combination had a negative effect, when combined less messages were shared than when each was part of the message individually (Vos et al., 2018). The use of metaphors in risk communications and the severity level of the risk communications were shown to have moderating effects on risk perceptions (Lu & Schuldt, 2018). Perceived risks were higher when the risk communication used metaphors and high severity level messages (Lu & Schuldt, 2018).

Media and Communication about Zika Virus

Sell and colleagues (2018) reviewed news media coverage of the Zika virus outbreak and response across 2016. Forty percent of news coverage included messages about the negative potential outcomes of Zika virus without mentioning ways to reduce risk (Sell et al., 2018). Ninety-six percent of news coverage contained at least one or more risk-elevating messages and 61% contained risk-minimizing messages (Sell et al., 2018). As media coverage decreased perceptions of threat decreased leading to challenges in communicating risk as the outbreak played less importance in the news media giving the perception that the outbreak danger had passed (Sell et al., 2018). News media outlets have been identified as a source for social amplification of risk, which puts

greater responsibility on news coverage messaging to be consistent with public health guidance for correct risk messaging (Sell et al., 2018; Tizzoni et al., 2020). As news media coverage shifted from scientific themes to social disruptions as time passed and the epidemic spread, knowledge and perceptions in the community shifted (Tizzoni et al., 2020). Tizzoni and colleagues (2020) determined that news volume and views of Wikipedia pages related to Zika virus were not related to the extent or progression of the Zika epidemic.

Protective behaviors and risk perceptions were associated with different types of media coverage (Chan et al., 2018). A difference in volume of information in legacy media (television, radio, newspapers, and online news sites) versus social media was followed by different change in community risk perceptions and protective behaviors (Chan et al., 2018). Legacy media was correlated with protective behaviors and social media was correlated with risk perceptions (Chan et al., 2018). Social media platforms were associated with different amounts of blame and different sentiments expressed by users based on platform and language used (Wirz et al., 2018). English posts on Twitter had 30% of posts assigning blame, while Spanish posts and Portuguese posts had 39% and 18%, respectively (Wirz et al., 2018). Facebook posts in English had 71% of posts assigning blame, while Spanish posts had 36% and Portuguese had 34% (Wirz et al., 2018). Overall, the language used in social media posts was associated with level of blame assigned with English and Spanish assigning more blame than Portuguese (Wirz et al., 2018). Different sentiments (positive, negative, or neutral) were measured across social media platforms pertaining to the use of genetically engineered mosquitos as a

prevention method (Wirz et al., 2018). Sentiments differed between Facebook and Twitter and amongst the three languages, English, Spanish, and Portuguese (Wirz et al., 2018). Twitter posts were predominantly neutral in sentiment for all three languages; English 50%, Spanish 44%, and Portuguese 46% (Wirz et al., 2018). Facebook posts were predominantly negative in sentiment for all three languages; English 64%, Spanish 62%, and Portuguese 45% (Wirz et al., 2018).

Healthcare provider websites were utilized to distribute health messages to patients during the Zika virus outbreaks, especially targeting pregnant women and women who might become pregnant through their obstetrician websites (Lehnert et al., 2017). Obstetric practice websites and associated social media accounts were reviewed across two time points, January 2016, and August 2016, to determine their use in disseminating Zika virus information to patients (Lehnert et al., 2017). Lehnert and colleagues (2017) determined there was a decrease in practices utilizing their websites for posting Zika virus information between the two time periods. McDonald and colleagues (2018) investigated the relationship between information sources and pregnant and inter-conception women's knowledge of Zika virus. Women who reported they found web-based and social media communications as helpful were more likely to know when Zika virus testing should be conducted (McDonald et al., 2018). Women who reported healthcare providers as a helpful source for communications were more likely to know two of the prevention methods, when to test for Zika virus infection, and how long to delay pregnancy after positive infection in a male partner (McDonald et al., 2018). A majority (75.3%) of the women reported hearing about Zika virus first from television or

radio, but only 9.5% of these women reported finding the information helpful (McDonald et al., 2018). Lehnert and colleagues (2017) highlighted the need for obstetrician practices to provide information for patients and McDonald and colleagues (2018) supported this finding with their determination that 40.3% of the women in their study found healthcare provider information to be helpful.

Miller and colleagues (2017) conducted an analysis of Twitter and determined the five main topics for each of the four Zika disease characteristics: symptoms, transmission, prevention, and treatment. The Twitter posts were analyzed for sentiments, opinions, misinformation, and specific aspects of Zika virus (Miller et al., 2017). Of the four disease characteristics, transmission and prevention were the most frequent topic of Twitter posts (Miller et al., 2017). Sentiment analysis indicated that most posts were negative, however the authors reported a higher number of positive posts than expected (Miller et al., 2017). The most frequent topics within prevention were the need to control and prevent spread and transmission; within treatment were the lack of treatment, symptoms, and Zika health effects (Miller et al., 2017). Laurent-Simpson and Lo (2019) conducted an analysis of the CDCs Facebook posts and responses to the posts. Within these posts three main themes emerged, Zika was a legitimate public health threat, the CDC was described as a corrupt organization, and medical expertise was questioned in regards to legitimate scientific methods used in research on Zika virus (Laurent-Simpson & Lo, 2019). The posts claiming the CDC was a corrupt organization undermined the messages from the CDC and led sentiments to distrust the messages that Zika virus was a serious health threat (Laurent-Simpson & Lo, 2019). Additionally, posts questioning the

scientific methods and data on Zika virus further undermined the messages from the CDC (Laurent-Simpson & Lo, 2019).

Misinformation and the spreading of fake news related to Zika virus and the CDC has impacted the public's uptake of public health messages and led to distrust in the health information (Laurent-Simpson & Lo, 2019; Miller et al., 2017; Sommariva et al., 2018). Miller and colleagues (2017) analysis of Twitter posts indicated misinformation was seen in posts mentioning Zika as a hoax due to misinterpretation of a quote from the CDC that mentioned the asymptomatic nature of the disease. Additional posts analyzed claimed a link between neurological issues and larvicide use and drawing comparisons between Zika virus having no or low death rate and the common cold being referred to as an epidemic (Miller et al., 2017). Sommariva and colleagues (2018) analyzed messages posted to social networking sites to examine truthful messages and misinformation. About 23% of the news stories analyzed were identified as rumors or misinformation and tended to place blame for the organization on individuals or organizations and discussed pesticides (Sommariva et al., 2018). The posts with misinformation were shared three times more often than the posts with verified content (Sommariva et al., 2018). The misinformation posts were further analyzed into three categories; 81% fabricated content, 16% misleading content, and 3% false connections (Sommariva et al., 2018). The CDC had attempted to combat the misinformation with their own social media posts that provided correct information and by answering questions posted on their social media sites (Miller et al., 2017).

Park and colleagues (2019) investigated the relationship between information channel used to gather health information in routine and crisis situations. There was a significant difference seen between the information channel used during routine and crisis situations; television news, health department websites, and medical professionals were the three most frequently reported sources for information in crisis situations while television news, medical professionals, and family and friends were the three most frequently reported sources during routine situations (Park et al., 2019). There was no significant difference in communication source for low and high-risk groups or low and high knowledge groups (Park et al., 2019). There were significant differences seen in communication source for low and high preparedness and low and high intention to follow instructions (Park et al., 2019). Overall, significant differences were seen in perceived risk, preparedness, and knowledge based on the communication source (Park et al., 2019).

Communication type impacted the perception of risk in various populations over time (Brittain et al., 2019; Juarbe-Rey et al., 2018; Wirz et al., 2020). Wirz and colleagues (2020) analyzed the impact of media attention of Zika virus and American's risk perceptions. Risk perceptions were enhanced by attention to international coverage and public health agency websites and were reduced by attention to website information and television news (Wirz et al., 2020). The judged need for U.S. action was enhanced by exposure to domestic news coverage, BBC, and CNN; but was reduced by attention to television and local newspapers (Wirz et al., 2020). Brittain and colleagues (2019) conducted a rapid assessment in the U.S. Virgin Islands that evaluated the level of

knowledge for preventing sexual transmission of Zika virus. It was determined that messaging needs to emphasize facts with statistics, but avoid scare tactics; and women were most interested in learning more about the costs, side effects, safety, and reversibility of contraception methods available (Brittain et al., 2019). The primary sources of health messages should be websites, social media, public events, and local radio to reach most of the population on the islands (Brittain et al., 2019). The health messages need to include a community member as a spokesperson to help with message uptake (Brittain et al., 2019). Sell and colleagues (2020) described the communication practices that were in place during the Zika virus outbreaks from 2016 to 2017. There was one major challenge identified in communicating timely public health information, media engagement waned and perception of the threat of Zika subsided (Sell et al., 2020). Juarbe-Rey and colleagues (2018) used Community Based Participatory Research to identify and create risk communication strategies for Zika virus prevention and control. The risk communication strategies developed included an awareness health fair, theater performances, and two targeted community forums (Juarbe-Rey et al., 2018). These risk communication strategies led to increased risk perceptions, increased knowledge of prevention behaviors, increased engagement in prevention behaviors, and increased acknowledgement of personal and community responsibility in preventing Zika virus transmission (Juarbe-Rey et al., 2018).

Public health messages directly impacted the knowledge of Zika virus and therefore the ability to engage in preventive behaviors (Chan et al., 2018; Ellingson et al., 2017; Howells et al., 2018; Prue et al., 2017; Squiers et al., 2019). Overall, news articles

reported mosquito transmission more often than sexual transmission and rarely (10% of articles) mentioned health outcomes that occurred in infections after birth (Squiers et al., 2019). Ellingson and colleagues (2017) found that the top sources for Zika information were reported as 73% used the CDC website, 44.5% used other pregnancy-related website, and 32.3% used state health department websites. In the evaluation of important qualities desired in public health messages participants reported 87.5% desired evidence-based content, 74.1% desired content endorsed by the CDC, and 67.9% desired content endorsed by their healthcare providers (Ellingson et al., 2017).

Public health message content impacts the community's response to disease outbreaks, including risk perceptions and prevention behaviors (Howells et al., 2018; Poehlman et al., 2019; Prue et al., 2017). Samoan leaders were resistant to the 2016 CDC Zika virus prevention efforts of providing contraception as it was believed this would promote premarital sex in the younger population (Howells et al., 2018). Beliefs about condom use led to health messages omitting this as a prevention method and created a lack of knowledge for prevention in high-risk populations (Howells et al., 2018). Prue and colleagues (2017) discovered that most of the participants had heard of Zika virus and cited public health messages that included information on causes and consequences of Zika virus infection. However, these messages were lacking enough information for participants to understand effective prevention methods (Prue et al., 2017). The Detén el Zika campaign focused on "Why" and "How" messages, after robust message testing determined these were important aspects to the messages and focused on positive tone in the messages, using uplifting and encouraging language (Poehlman et al., 2019). Support

from the CDC and community engagement in the message testing led to successful implementation of the Detén el Zika campaign in Puerto Rico (Poehlman et al., 2019).

Frequency of media exposure and interpersonal messages amplified risk perceptions (Yang et al., 2018). Fear acted as a motivator for engaging in protective health behaviors (Yang et al., 2018). Fear was seen as a positive function of frequency of exposure to messages; personal relevance of messages predicted fear response, and interpersonal communication acted to increase fear response (Yang et al., 2018). Guidry and colleagues (2018) evaluated the effects of framing and visual type in Zika health messages on intent to be vaccinated against Zika virus. Unlike Yang and colleagues' (2018) findings, Guidry and colleagues (2018) found that gain-framed messages had more impact on vaccine uptake intent than loss-framed messages. Gain-framed messages focused on the benefits of becoming vaccinated and loss-framed messages focused on the consequences of not becoming vaccinated (Guidry et al., 2018).

Brittain and colleagues (2019) performed a rapid assessment of communication efforts in the U.S. Virgin Islands to determine improvements that would lead to increased uptake of preventive behaviors. Communication efforts need to focus in local risks and unintended pregnancy prevention methods as a primary strategy to preventing adverse outcomes related to Zika virus infection (Brittain et al., 2019). Community members need to be involved in the creation of public health messages to ensure better message uptake (Brittain et al., 2019). Prue and colleagues (2017) performed a rapid assessment of public health messages in the U.S. Virgin Islands to inform public health officials of the gaps in messaging. The gaps in messaging identified by this study included education about

sexual transmission of disease and prevention methods of condom use and abstinence (Prue et al., 2017). The U.S. Virgin Islands Department of Health used the information from this study to improve their public health message campaign and vector control plan (Prue et al., 2017).

Communication strategy barriers led to many challenges in distributing public health messages to high-risk populations during the Zika virus outbreaks (Ophir & Jamieson, 2020; Poehlman et al., 2019; Sell et al., 2020). Sell and colleagues (2020) identified barriers as mistrust of the government, anxiety about U.S. residence status, socioeconomic concerns, and staffing shortages in public health departments. Puerto Rico's response to Zika outbreaks were challenged by mistrust of vector control methods and fatigue for vector control strategies, due to other endemic diseases transmitted by shared vectors (Poehlman et al., 2019). Ophir and Jamieson (2020) investigated the U.S. public's familiarity, knowledge, and behaviors in response to the news media's coverage of Zika virus from February through September of 2016. The public had higher levels of knowledge about mosquitos than adverse health effect of microcephaly, less knowledge of sexual transmission was seen, and the lowest levels of knowledge about the asymptomatic nature of Zika virus infection (Ophir & Jamieson, 2020). Overall, levels of knowledge were consistent with the amount of media coverage the participants were exposed to (Ophir & Jamieson, 2020). This showed a direct link between the amount of news coverage of the disease and the specific topics covered with the public's familiarity, knowledge, and behaviors (Ophir & Jamieson, 2020).

Public Health Response to Zika Virus Outbreaks

In response to the Zika virus outbreaks seen across the world, the CDC and the WHO provided frequent updates and guidance for testing, treatment, and prevention of Zika virus. In 2015, the WHO declared the Zika virus outbreaks a public health emergency due to the high incidence of microcephaly cases seen in the Americas (Alaali et al., 2020). By January 2016, Zika virus was added to the list of diseases on the Nationally Notifiable Disease list, requiring laboratories and healthcare providers to report all suspected cases to state or local health departments (McNeill et al., 2016). Local and state health departments were responsible for providing guidance on testing, diagnosis, and controlling local transmission of disease (McNeill et al., 2016).

On February 5, 2016, the CDC issued interim guidance for the prevention of sexual transmission of Zika virus that included guidance for men and their pregnant partners and men and their non-pregnant partners (Oster, Brooks, et al., 2016). Men who lived or travelled to an area with active Zika transmission were recommended to abstain from sex or use condoms during sex for the duration of their partners pregnancy (Oster, Brooks, et al., 2016). Men who lived or travelled to an area with Zika transmission but do not have pregnant partners should abstain from sex or use condoms during sex if concerned about transmission of Zika virus (Oster, Brooks, et al., 2016). Testing for Zika virus infection was recommended to aid in diagnosis for pregnant women (Oster, Brooks, et al., 2016).

On March 25, 2016, the CDC issued updated interim guidance for the prevention of sexual transmission of Zika virus for men and their pregnant partners (Oster, Russell,

et al., 2016). The guidance included a 6-month period for men with confirmed infection to abstain or use condoms to prevent sexual transmission (Oster, Russell, et al., 2016). Testing recommendations were outlined for individuals who had possible sexual exposure incidents and if they develop symptoms of infection (Oster, Russell, et al., 2016). Additionally, pregnant women who had potential exposure should be tested only if they or their partners developed symptoms of infection (Oster, Russel, et al., 2016).

In June 2016, the WHO published guidance for the prevention of sexual transmission of Zika virus (Byron & Howard, 2017). The WHO guidance included advice for symptomatic men returning from Zika-infected areas to practice safe sex for 6 months to prevent transmission to their partners (Byron & Howard, 2017). Health programs were advised to provide condoms to people with Zika virus and that men and women in Zika outbreak areas be educated on delaying pregnancy as a prevention for adverse fetal outcomes (Byron & Howard, 2017).

On July 25, 2016, the CDC issued updated guidance for pregnant couples and couples who are not pregnant and not planning to become pregnant (Brooks et al., 2016; Capitulo, 2016; Shields, 2016). The updated guidance was the same for both groups, consistent use of contraception to prevent sexual transmission of Zika virus if there had been recent travel to areas with Zika transmission (Brooks et al., 2016; Capitulo, 2016). Additional testing guidance was provided and indicated that individuals who have exhibited symptoms or had exposure to Zika virus through sex should be tested and all pregnant women who have had exposure should be tested (Brooks et al., 2016; Capitulo, 2016). Along with the updated guidance the CDC rolled out a new toolkit to help educate

healthcare providers and help providers educate patients (Shields, 2016). The toolkit included screening for Zika virus, counseling on contraceptives and sexual health, strategies to prevent unwanted pregnancies, and family planning services (Shields, 2016).

On August 24, 2016, the CDC updated their guidance for healthcare providers caring for pregnant women and included a new Zika Toolkit (Hatcher et al., 2016b). The CDC conducted a study to determine the prevalence of contraceptive use among non-pregnant and post-partum women and concluded that state and local agencies need to engage in activities to reduce unintended pregnancies and improve contraceptive use to reduce the number of Zika impacted pregnancies (Hatcher et al., 2016b). The Zika Toolkit included information for healthcare providers to discuss family planning options with patients; including exposure screening, educational information, Zika prevention techniques, and contraceptive services (Hatcher et al., 2016b).

In September 2016, the WHO issued updated guidance from their June 2016, guidance for the prevention of sexually transmitted Zika infection (Byron & Howard, 2017). The WHO guidance expanded the original advise for men traveling from Zika outbreak areas to all individuals travelling from outbreak areas to practice safe sex for at least 6 months to prevent transmission (Byron & Howard, 2017). Updated advice from heath programs to all individuals in Zika outbreaks areas to use condoms to prevent transmission and no longer advises to delay pregnancy, but rather that health care providers should educate and offer contraceptive methods to assist individuals with making informed family planning decisions (Byron & Howard, 2017). The changes to the WHO guidance from June to September mostly focused on expanding the target for

protective behaviors and removing suggestion of delaying pregnancy in response to infection risk (Byron & Howard, 2017).

On September 30, 2016, the CDC published guidance for Zika virus prevention covering persons with potential Zika virus infection who are planning on conceiving and prevention through sexual transmission (Hatcher et al., 2016a; Petersen et al., 2016; Wisner, 2020). Included in this guidance was the recommendation that couples trying to conceive avoid all non-essential travel to areas with Zika virus transmission, a waiting period of 8 weeks is recommended for women with potential Zika virus infections from symptom onset or last exposure incident, extended waiting period for male partners in couples attempting conception of at least 6 months from last exposure or symptom onset, and guidance that all couples not attempting to conceive should correctly use condoms or abstain from sexual contact for at least 6 months from symptom onset or last exposure incident for males and at least 8 weeks for females (Hatcher et al., 2016a; Petersen et al., 2016; Wisner, 2020). The Office of Population Affairs rolled out a Zika Toolkit to help implement the CDC guidance for prevention of Zika virus sexual transmission (Hatcher et al., 2017a). The Female Health Company worked with health departments to provide female condoms, educational materials, and attended decision making meetings to assist with prevention strategies and Zika Toolkit creation (Hatcher et al., 2017a).

The United States Congress approved a Zika funding bill of $1.1 billion towards the vaccine development, research, and prevention (Greer & Singer, 2017; Hatcher et al., 2016a). The bill included allocations for vector control ($394 million), vaccine development and enhanced testing ($397 million), and healthcare for individuals

impacted in Puerto Rico and U.S. territories ($66 million) (Hatcher et al., 2016a). The United States Congress took 220 days to pass the Zika funding bill due to fragmentation of public health responsibilities and polarization of Congress; in that time the United States went through an entire mosquito season allowing for the transmission of Zika vector mosquitos within the United States (Greer & Singer, 2017). While Congress worked on the Zika funding bill the administration had to take funding from Ebola and influenza funds to resource the government's response to Zika in the United States (Greer & Singer, 2017).

In August 2017, the CDC updated their guidance for healthcare providers caring for pregnant women due to the decreased incidence of Zika virus infections in the U.S. (Wetzel, 2017). Updated guidance included screening for all pregnant women, testing for pregnant women with recent exposure and symptoms of infection, testing of pregnant women with continual exposures at least three times throughout their pregnancy, and testing not recommended for non-pregnant women or men who are asymptomatic with recent exposure (Wetzel, 2017). Testing before pregnancy was not recommended in the updated guidance, but if pregnant with a possible exposure incident and ultrasound findings of the fetus are consistent with Zika syndrome, then testing by nucleic acid testing and serologies are recommended (Wetzel, 2017).

By May 2018, media coverage had decreased regarding Zika virus health messages even though transmission continued to persist in South and Central America, Southeast Asia, India, Pakistan, Africa, and the Pacific Islands (Ros, 2018). Healthcare providers were advised to continue screening patients for exposure to Zika virus,

recommend testing of pregnant women with exposure incidents (Ros, 2018). On August 7, 2018 the CDC posted new recommendations for men with potential Zika exposure, whose partners were planning on conceiving, advising them to wait at least 3 months after symptoms appeared or after their last exposure incident before trying to conceive (Polen et al., 2018; Wisner, 2020).

Collaboration directly with the CDC through partnership programs or support from the CDC was a key component for many Zika response plans (Earle-Richardson et al., 2018; Hatcher et al., 2016c; Hatcher et al., 2017b; Heberlein-Larson et al., 2019; Philip et al., 2019; Vasquez et al., 2016). The Florida Department of Health was able to effectively control the Zika virus outbreak and prevent local transmission by following their Zika Playbook (Heberlein-Larson et al., 2019; Philip et al., 2019). The Zika Playbook highlighted the importance of collaboration with the CDC for mosquito prevention methods, increased mosquito and disease surveillance, and proper identification of risks of infection (Philip et al., 2019). The Florida Department of Health's Bureau of Public Health Laboratories (BPHL) was responsible for conducting Zika virus testing and partnered with federal and commercial laboratories to conduct Zika virus testing with an average turnaround time of 1-4 days for nucleic acid testing and 3-7 days for serologic testing (Heberlein-Larson et al., 2019). While the BPHL prepared for testing as part of the Florida Department of Health's response to Zika, they could not predict the testing volume needs for asymptomatic pregnant women since the Zika response plans did not initially include guidance from the CDC recommending testing for pregnant women (Heberlein-Larson, et al., 2019). The University of Miami Miller School

of Medicine created and implemented a Zika response plan as soon as the governor declared a state of emergency for Florida (Voelker, 2016). The Zika response plan included educational information for patients through counseling and their maintained website linking to the CDC, while the Medical School became a referral site for local doctors who were uncertain how to identify infected patients or how to care for them (Voekler, 2016).

In 2016, the CDC published guidance for pregnant women and announced the convening of a summit to address the threat of Zika virus in the United States (Daniel, 2016). Pregnant women were advised to take special precautions to prevent Zika virus infection by avoiding travel to outbreak areas, using condoms during sexual activities, or abstaining from sexual activity while pregnant if their male partners lived in or travelled to areas with active outbreaks (Daniel, 2016). The Zika Action Plan Summit provided state and local government officials with the information necessary to develop response plans and improve Zika preparedness (Daniel, 2016).

The CDC had provided guidance for all infants with suspected congenital Zika syndrome to receive brain imaging as a confirmatory method, however surveillance indicated this was followed at a rate of 1 in 4 (Hatcher et al., 2017b). The CDC rolled out education outreach for healthcare providers in an effort to increase the uptake of guidance for brain imaging of suspected cases (Hatcher et al., 2017b). The American College of Obstetricians and Gynecologists (ACOG) provided guidance that all couples, in which the woman is pregnant, should correctly use condoms or abstain from sex to minimize risk of Zika transmission (Hatcher et al., 2016c; Wisner, 2020). Additionally, ACOG has

reported that efforts are needed to improve access to information about Zika virus and pregnancy and access to contraceptive methods (Hatcher et al., 2016c).

Earle-Richardson and colleagues (2018) reviewed the impact of Puerto Rico's Department of Health (PRDOH) response to Zika virus. The PRDOH emergency operations center was activated in 2016 with the support of the U.S. CDC (Earle-Richardson et al., 2018; Poehlman et al., 2019). The public health prevention campaign methods utilized by PRDOH were the Women, Infants, and Children (WIC) Program Zika Orientation, Zika Prevention Kit distribution, Detén el Zika, and free residential mosquito spraying (Earle-Richardson et al., 2018). The Detén el Zika campaign launched June 30, 2016 on Zika Action Day and included a large media campaign that utilized radio, television, print, and social media to spread the message of proper prevention techniques (Earle-Richardson et al., 2018; Poehlman et al., 2019). Participants who received the Zika Prevention Kit had a positive association with larvicide application and use of bed nets and participation in free mosquito spraying was positively associated with spraying the home for mosquitos (Earle-Richardson et al., 2018). The Puerto Rico Department of Health collaborated with the CDC on a rapid assessment of blood collection and use (Vasquez et al., 2016). Blood supply and safety issues in Puerto Rico were discovered, leading to a federally supported effort to import blood components from the continental U.S. to meet local demands until April 2, 2016, when the FDA approved screening of blood and blood component donations in the U.S. (Vasquez et al., 2016).

Dehlendorf and colleagues (2017) reviewed the response efforts conducted by eight states at high-risk of mosquito-borne transmission, in partnership with the U.S.

Office of Population Affairs. During the initial meeting of these officials there was a determination that family planning had been under-represented in the Zika response plans; missing an opportunity to engage family planning providers in the response to Zika virus (Dehlendorf et al., 2017). Additionally, the challenges to family planning being part of the Zika response were addressed, including expanding access to quality care, limited funding for family planning activities, and lack of established communication networks between state and federal agencies (Dehlendorf et al., 2017). At the follow up meeting these states reviewed their progress in rolling out their response plans and engagement of family planning providers (Dehlendorf et al., 2017). Several states reported a successful rollout of family planning components to their response plans, more than half the states reported routine Zika virus exposure screening of patients by family planning providers, and progress on expanding access to quality care (Dehlendorf et al., 2017).

Responses to the Zika virus pandemic were varied and individualized by state or city health departments (Avery et al., 2020; Heitzinger et al., 2018; Hornstein et al., 2019; Krisberg, 2017; Lee et al., 2016). In January 2016, the New York City Department of Health and Mental Hygiene (NYC DOHMH) published guidance for symptomatic pregnant women who traveled to or had sexual contact with someone who traveled to an area that had mosquito-borne Zika virus transmission to be tested for Zika virus (Lee et al., 2018). This guidance was expanded to include asymptomatic pregnant women as well to help provide pregnant women with information needed to make crucial decisions regarding their options earlier in pregnancy (Lee et al., 2018). The NYC DOHMH conducted a review of the Zika virus testing performed on pregnant women to identify

health disparities in testing and target populations in most need for increased access to testing services (Lee et al., 2018). Baseline data from the review indicated that women most as risk of Zika virus infection were initially the least likely to be tested for Zika infection (Lee et al., 2018). The NYC DOHMH launched a program to target the most at-risk women and increased access to testing for women in low-income areas (Lee et al., 2018). In February 2016, the NYC DOHMH activated the Incident Command Center, developed management plans, and mobilized 328 specially trained individuals to conduct Zika virus surveillance (Lee et al., 2016). The response included diagnostics laboratory testing for individuals with travel associated exposures, education for the public and healthcare providers, monitoring pregnant women with active Zika infection, detecting local transmissions through human and mosquito surveillance, and vector control measures that modified existing measures to target the *Aedes* mosquitos (Lee et al., 2016). The New York State Department of Health (NYSDOH) created a Zika Pregnancy and Infant Registry (ZPIR) to monitor and collect data on all pregnant women with confirmed cases of Zika virus and their outcomes (Alaali et al., 2020). The CDC and NYSDOH used the ZPIR to monitor confirmed cases of infection during pregnancy and track health outcomes; collected data included pregnancy details, exposures, travel history, and birth outcomes (Alaali et al., 2020). New York State required all confirmed cases of zika virus to be reported in addition to the tracking of pregnancies through the ZPIR program (Alaali et al., 2020). In response to Zika virus outbreaks in Texas, the Harris County Public Health (HCPH) department created a comprehensive Zika response plan that included the full epidemiological investigation into each reported potential Zika

virus infection in Harris County, Texas (Hornstein et al., 2019). The HCPH team was able to identify disease cases and infections while providing education to providers on the frequently updated recommendations from the CDC (Hornstein et al., 2019). Additionally, the HCPH was able to ensure proper testing for the suspected cases and educate patients on the travel advisories from the CDC (Hornstein et al., 2019).

Heitzinger and colleagues (2018) evaluated the knowledge, attitudes, and practices of women of childbearing age who had received a negative Zika virus test in Kentucky to assess the impact of the Kentucky Department for Public Health's (KDPH) response to Zika virus. The KDPH followed CDC recommendations for public health messages and issued multiple press releases, added Zika information to their website, and hosted a media event to educate local public health departments (Heitzinger et al., 2018). As a result of these efforts the women surveyed reported Zika was transmissible through mosquitos (>90%), causes birth defects (>90%), infection could be asymptomatic (84%), virus could be sexually transmitted (56%), and 87% believed they could prevent infection (Heitzinger et al., 2018).

Avery and colleagues (2020) investigated the relationship between state and federal health advisories and the public's perceived risk and perceived preparedness. State and federal advisories significantly impacted perceived preparedness as a predictor of preparedness (Avery et al., 2020). The state of Louisiana took a proactive approach to the prevention of Zika virus transmission; with community outreach, surveillance, testing, and intervention plans (Krisberg, 2017). In the fall of 2016, Congress approved

$1.1 billion in emergency funds to help states prepare and prevent Zika virus transmission (Krisberg, 2017).

Educational outreach was determined to be a necessary component of any public health campaign for the prevention of Zika virus transmission and resurgence (Blocker & Wilson, 2018). Educational plans should include: limiting the spread of Zika virus; collaboration between the CDC, WHO, and Mexico's National Department of Health; materials in English and Spanish; easy to identify pictographs; and be easy to distribute like pamphlets, billboard ads, television ads, and social media posts (Blocker & Wilson, 2018). Berenson and colleagues (2017) evaluated the knowledge, attitudes, and prevention methods employed by pregnant women living in Texas. Gaps were identified in participant's knowledge of Zika virus and there was an expressed desire for more information (Berenson et al., 2017). Prevention education methods were lacking but indicated as important for protection of pregnant women residing in Texas (Berenson et al., 2017). Additionally, Berenson and colleagues compared women born in the United States and women born in outbreak areas to determine if there was a difference in knowledge or behaviors (Berenson et al., 2017). Overall, women born in outbreak areas had higher levels of knowledge and were more likely to be interested in receiving a vaccine than women born in the United States (Berenson et al., 2017). The response to the Zika virus outbreak took on many forms depending on the organization responding to outbreaks; the CDC continually updated guidance to assist local health departments with their response efforts and went as far as creating collaborative programs in areas with the greatest need of support. The ability for these responses to change and evolve as new

information was learned about Zika virus led to better support for and improved knowledge of the communities served by these organizations.

Summary and Conclusions

The literature reviewed covered many aspects of the Zika virus outbreaks in the United States and the impact of those outbreaks on American's knowledge, awareness, risk perceptions, prevention behaviors, intentions to engage in prevention behaviors, risk communication messages, media/communications about Zika virus, and the public health response to Zika virus outbreaks. Risk perceptions for Zika virus have been shown to be impacted by exposure to health information, residence location, and knowledge of Zika virus transmission routes (Johnson, 2018; Johnson, 2019b). The intention to engage in prevention behaviors was impacted by the following: risk perceptions, belonging to a household with a pregnant woman, and knowledge of Zika virus (Chan, Farhadloo, et al., 2018; Jaffe et al, 2020; Ophir & Jamieson, 2018; Reynolds e al., 2019). Prevention behaviors against Zika virus included the following: removal of mosquito breeding sites, wearing protective clothing, practicing safe sex when exposures had taken place, genetically engineered methods, etc. (Daughton & Paul, 2019; Moise et al., 2018). Factors influencing engagement in prevention behaviors were determined to be the following: knowledge of Zika virus, risk perceptions, removal of barriers to use prevention methods, and confidence in local health and government officials (Ahrens et al., 2017; Berenson et al., 2017; Heitzinger et al., 2018; Hills et al., 2016; Voelker, 2017). The communication of risk messages to at-risk communities had proved challenging for public health departments due to rapidly changing information, however the use of

community based participatory research improved message tailoring and uptake in the community (Byron & Howard, 2017; Capitulo, 2016; Hatcher, et al., 2016a; Oster, Brooks, et al., 2016; Shields, 2016, Wisner, 2020). The inclusion of risk messages in heath campaigns improved the likelihood of prevention method uptake (Chan et al., 2018). Media and communications about Zika virus evolved over time as more scientific information became available. The changes in messages challenged public health departments and healthcare providers to keep up with the science and provide updated information to patients and the community (Sell et al., 2018; Tizzoni et al., 2020). Several public health campaign methods and media outlets proved successful at engaging the community in prevention behaviors and improving overall knowledge about Zika virus transmission, symptoms, and outcomes. Public health responses to the Zika virus outbreaks were conducted at the local health department level; leading to a variety of campaigns and educational efforts (Avery et al., 2020; Heitzinger et al., 2018; Hornstein et al., 2019; Krisberg, 2017; Lee et al., 2016). The WHO and the CDC continually updated their health messages and directives to the public and healthcare providers as the data continued to be gathered (Byron & Howard, 2017; Capitulo, 2016; Hatcher, et al., 2016a; Oster, Brooks, et al., 2016; Shields, 2016, Wisner, 2020). Additionally, many local health departments followed this guidance or engaged in collaborative efforts with national level health organizations to support their communities (Earle-Richardson et al., 2018; Hatcher et al., 2016c; Hatcher et al., 2017b; Heberlein-Larson et al., 2019; Philip et al., 2019; Vasquez et al., 2016).

While the literature reviewed exhausts many aspects of the Zika virus outbreaks, there remains a gap in identifying the relationship between local health departments' level of engagement in education and prevention activities and the impact to the community's risk perceptions. The current literature addressed risk perceptions, knowledge, prevention behaviors, perceived benefits, perceived barriers, cues to action, and self-efficacy as it relates to Zika virus. This study addressed the identified gap in the existing literature by determining the relationship between the local health departments' level of engagement in plans for education and prevention programs and their community's risk perceptions. The methodology that was used to study these relationships will be described in Chapter 3.

Chapter 3: Research Method

Introduction

The purpose of this study was to examine the relationship between local health departments' plans for education and prevention programs and their community's risk perceptions related to Zika virus. Secondary data, including survey questions of health departments regarding Zika virus prevention and education plans, were compared to secondary data that included survey questions of the community's perceived risks. The comparison of these two secondary datasets clarified the relationship between prevention and education plans and perceived risks at the state level.

This chapter will address the research design and rationale used by the researchers of the secondary datasets: Forces of Change Survey (NACCHO, 2017a) and RAPID: Assessing the Variance, Effects, and Sources of Aversion to Zika Solutions (Johnson, 2019a). The methodology used for this secondary data analysis study will be discussed in detail. Finally, this chapter will address the ethical procedures related to the use of these secondary datasets.

Research Design and Rationale

The independent variables were the survey questions from the dataset Forces of Change Survey, which measured the levels of engagement for the local health departments through education and prevention activities (NACCHO, 2017a). The first three survey questions below were considered the level of engagement in prevention, and the second three survey questions below were considered the level of engagement in education. The survey questions prompted the respondent to "Indicate [their] LHD's level

of engagement (currently or during your most recent mosquito season) in the following activities for Zika prevention and response." (NACCHO, 2017a)

1. Vector control to suppress Zika virus transmission
2. Public health surveillance and epidemiological investigation
3. Conducting and/or coordinating lab testing
4. Providing information to travelers about Zika risks and protection measures
5. Clinician outreach and communication on Zika clinical care guidelines
6. Risk communication/community education to inform the public about Zika virus and related illnesses

The dependent variable was a recoded variable combining the survey questions from the dataset RAPID: Assessing the Variance, Effects, and Sources of Aversion to Zika Solutions assessing risk perceptions by the community, including: (Johnson, 2019a)

1. How much risk does the Zika virus pose to you or your family?
2. How much risk does the Zika virus pose to the U.S.?

This study was a quantitative secondary data analysis, combining two datasets: the Forces of Change Survey (ICPSR 37141) and the RAPID: Assessing the Variance, Effects, and Sources of Aversion to Zika Solutions. The Forces of Change Survey was conducted as a cross-sectional study designed to understand the individual states plans for prevention of infection and education of the public on risk factors for Zika virus (NACCHO, 2017a). The RAPID survey was conducted as a longitudinal study of individuals risk perceptions and protective actions towards Zika virus (Johnson, 2019a). The common variable between the two datasets that allows them to be combined was

State. In the RAPID Survey, this was part of the survey questions asking which State the participants currently resided; in the Forces of Change Survey, this was one of the survey questions posed to public health workers. The use of secondary data mitigates any time constraints that would be seen with conducting the surveys. Quantitative data analysis was conducted on the secondary data and yielded a determination of the relationship between prevention and education plans at the local health department level, along with their community's risk perceptions.

Methodology

Population

The Forces of Change Survey researchers contacted 948 local health departments (LHDs) across all states in the United States as part of their targeted population (NACCHO, 2017a). The researchers received responses from 615 LHDs, a response rate of 65% (NACCHO, 2017a). The RAPID Survey included a target population of non-institutionalized adults over the age of 18 residing in the United States (Johnson, 2019a). The number of participants in the RAPID Survey included 743 individuals over the study period of July 19, 2016, to April 23, 2017 (Johnson, 2019a). This study included all the participant data from the RAPID Survey and the Forces of Change Survey for a total of 1,358 participants. The calculation was conducted using the software G*Power to determine the total sample size of 568 participants was needed for statistical significance (significance level of $p = 0.05$).

Sampling and Sampling Procedures

The Forces of Change Survey utilized random sampling of LHDs stratified by size of population served and State (NACCHO, 2017a). Three size categories were used for the stratification by size. Less than 50,000 people served was classified as small; 50,000 to 499,999 people served was classified as medium; and more than 500,000 people served was classified as large (NACCHO, 2017a). Oversampling of large population size LHDs was conducted to ensure sufficient responses were received; large population size LHDs represent a small number of LHDs (NACCHO, 2017a). Hawaii and Rhode Island were excluded from the study due to the lack of LHDs in those States (NACCHO, 2017a). The stratification method led to 122 total strata, and the sampling plan aimed to capture 33% of the LHDs in each stratum, and at least two LHDs from each stratum (NACCHO, 2017a). The survey was conducted online using Qualtrics online survey administration tool (NACCHO, 2017a).

The RAPID Survey included two survey collections: one national convenience sample facilitated by Survey Sampling International, and one convenience sample facilitated by Decision Research (Johnson, 2019a). Both surveys were conducted online, and only participants invited to participate were granted access to the surveys (Johnson, 2019a).

Recruitment, Participation, and Data Collection Procedures

The data for the Forces of Change Survey was collected by NACCHO by online surveys sent to a random sampling of LHD contacts (NACCHO, 2017a). On February 14, 2017, NACCHO's president emailed each of the randomly chosen LHD's contacts,

inviting the individuals to participate in the online survey; then, a follow up link for the Qualtrics online survey site was sent via email (NACCHO, 2017a). The Forces of Change Survey required restricted data access approval through the Institute for Social Research, University of Michigan (ICPSR) website. The submission application took place after the Walden IRB approved this study. Once the restricted data access approval was received, the data was downloaded to the ICPSR, University of Michigan Virtual Data Enclave (VDE) for analysis.

The data for the RAPID Survey was collected over nine months in four waves of surveys administered by Decision Research through their online survey panel. The Decision Research online panel was comprised of a diverse recruitment of adults across genders, ages, and education level, which was intended to be a representative sampling of adults in the United States (Johnson, 2019a). The RAPID Survey is an open use dataset and was downloaded after IRB approval had been received. The dataset was then downloaded into the ICPSR, University of Michigan VDE for analysis.

Instrumentation

The Forces of Change Survey is an established instrument utilized by NACCHO for yearly surveys. Validity of the Forces of Change Survey was confirmed by NACCHO through review by subject matter experts, and through internal comparison of some results to determine accuracy of responses (NACCHO, 2017a). Some of the questions on the survey were reused from previous studies; so, only new questions were reviewed for validity as part of the Forces of Change Survey for 2017 (NACCHO, 2017a). The RAPID survey does not utilize any existing instruments but did conduct a pilot survey to test the

survey questions (Johnson, 2019a). The pilot survey was administered by Survey Sampling International (Johnson, 2019a).

The RAPID Survey dataset contained the risk perception variables of interest for the current study and was combined with the Forces of Change Survey through the common variable "State." The Forces of Change Survey contained the level of engagement variables, for both education and prevention activities at the local health departments, of interest for this study. Combining these datasets allowed for the evaluation of the relationship between local health departments' level of engagement in prevention and education activities and the community's risk perceptions.

The Forces of Change Survey is conducted annually by NACCHO to measure the impact of the economic recession on LHDs budgets, staff, and programs (NACCHO, 2017a). Additionally, several health-related metrics are evaluated each year based on LHD program impact (NACCHO, 2017a). Specifically, the 2017 survey focused on addressing the LHD Zika prevention and response activities, multi-sectoral partnerships, and workforce recruitment efforts (NACCHO, 2017a). Data from the Forces of Change Survey have been used by NACCHO to determine the economic impact on LHDs (NACCHO, 2017b). The results of the study identified that LHDs had several Zika prevention and response activities, including public health surveillance, education aimed at the public and health providers, vector control measures, lab testing for Zika infection confirmation, and maternal and child health surveillance (NACCHO, 2017b).

The RAPID Survey has been used in other studies to discuss the factors that impacted health behavior decisions. Johnson (2018) studied the relationship between

residential location and psychological distance and risk perceptions and behavioral intentions towards Zika virus using the RAPID Survey. The results of the study indicated that residential location and psychological distance impacted risk perceptions and behavioral intentions (Johnson, 2018). The study conducted by Johnson (2019b) evaluated the factors influencing American's views on voluntary protective actions. Johnson (2019b) determined that health education exposure was an influencing factor impacting risk perceptions and perceived barriers influenced protective action behaviors.

Variables

The dependent variable was a composite of the two survey questions from the RAPID Survey, were self-reported by the participants, and were ordinal responses (Johnson, 2019a). The survey asked the participants to rank from "no risk" (rank of 0) to "very high risk" (rank of 5) their responses to the following questions (Johnson, 2019a).

1. How much risk does the Zika virus pose to you or your family?
2. How much risk does the Zika virus pose to the U.S.?

The scores were totaled into a new composite variable that was ordinal in nature and ranging from 0 (no risk) to 10 (very high risk).

The independent variables from the Forces of Change Survey were self-reported by the participants, and were nominal in responses (NACCHO, 2017a). The survey asked participants to indicate level of engagement in the following activities with responses of "agree or have been engaged", "planning to engage", "neither engaged, nor planning to engage", or "not sure" (NACCHO, 2017a). These responses were assigned numeric values of 1 through 4, respectively for data analysis (NACCHO, 2017a). Questions 1-3

below made up the level of engagement in prevention variable and questions 4-6 made up the level of engagement in education variable in this study. The responses of the survey questions below were combined into composite scores for prevention (questions 1-3) and education (questions 4-6).

1. Vector control to suppress Zika virus transmission
2. Public health surveillance and epidemiological investigation
3. Conducting and/or coordinating lab testing
4. Providing information to travelers about Zika risks and protection measures
5. Clinician outreach and communication on Zika clinical care guidelines
6. Risk communication/community education to inform the public about Zika virus and related illnesses

The common variable used in combining both datasets was "State." In the Forces of Change Survey this was presented as State (NACCHO, 2017a). In the RAPID Survey this variable was presented as "In which state do you currently reside?" (Johnson, 2019a). In both datasets State was self-reported by survey participants and was a nominal variable.

Data Analysis Plan

The two datasets were combined, and data analysis was performed using SPSS V28. Individually each data set has undergone review by the original researchers and missing data identified for each variable (NACCHO, 2017a; Johnson, 2019a). Once the two datasets were combined, the newly created dataset was reviewed and screened for missing data and accuracy of the merge feature in SPSS. The Forces of Change Survey

researchers addressed missing data by applying weights to the data based on states and population categories (NACCHO, 2017a).

RQ1 - Quantitative: What is the relationship between public health department's level of engagement for prevention of Zika virus infection and the community's perception of risk of contracting the virus?

H_{01} – There is no statistically significant relationship between public health department's level of engagement for prevention of Zika virus infection and the community's perception of risk of contracting the virus.

H_1 – There is a statistically significance relationship between public health department's level of engagement for prevention of Zika virus infection and the community's perception of risk of contracting the virus.

RQ2 – Quantitative: What is the relationship between public health department's level of engagement for community education on Zika virus and the community's perception of risk of contracting the virus?

H_{01} – There is no statistically significant relationship between public health department's level of engagement for community education on Zika virus and the community's perception of risk of contracting the virus.

H_1 – There is a statistically significant relationship between public health department's level of engagement for community education on Zika virus and the community's perception of risk of contracting the virus.

Table 1

Research Questions, Variables, and Statistical Analysis Plan

Research Question	Variable	Type of Variable	Coding of Variable	Statistical Test
RQ1: What is the relationship between public health department's level of engagement for prevention of Zika virus infection and the community's perception of risk of contracting the virus?	Vector control	Independent	1 = agree or have been engaged 2 = planning to engage 3 = neither engaged nor planning to engage 4 = not sure	Ordered Logistic Regression
	Public health surveillance	Independent		
	Lab testing	Independent		
	Risk perception	Dependent	0 = No risk 1-3 = low risk 4-6 = moderate risk 7-9 = high risk 10 = very high risk	
RQ2: What is the relationship between public health department's level of engagement for community education on Zika virus and the community's perception of risk of contracting the virus?	Providing information to travelers	Independent	1 = agree or have been engaged 2 = planning to engage 3 = neither engaged nor planning to engage 4 = not sure	Ordered Logistic Regression
	Clinician outreach and communication	Independent		
	Risk communication/community education	Independent		
	Risk Perception	Dependent	0 = No risk 1-3 = low risk 4-6 = moderate risk 7-9 = high risk 10 = very high risk	

An ordered logistic regression analysis was performed on the variables identified to address the research questions noted above. The level of engagement in prevention and education were analyzed using three survey questions measuring the level of engagement in each activity. In analyzing these questions together to address the research question, an

ordered logistic regression was needed to compare the dependent variable of risk perception to the three survey questions. The assumptions of ordered logistic regression include: ordinal dependent variable, independent variables are either continuous, categorical, or ordinal, no multicollinearity, and proportional odds. To test the assumptions for ordered logistic regression the datasets were reviewed to ensure there were no violations. The dependent variable was ordinal; therefore, the assumption of ordinal dependent variable was not violated. The independent variables were all categorical, meeting the assumption of independent variables needing to be either continuous, categorical, or ordinal. SPSS software was used to test for multicollinearity using the variance inflation factor. The proportional odds assumption was tested by conducting the Test of Parallel Lines in SPSS. If any of the assumptions were violated, the data analysis methods were re-evaluated and a more appropriate method chosen. The results of the ordered logistic regression analysis determined if there was a significant relationship between the dependent and independent variables. The ordered logistic regression analysis was evaluated based on the model fitting output in SPSS, including the Chi-square and *p*-value results to determine if the model fits, and based on the parameter estimates output in SPSS, including the Estimate results to determine the relationship between the dependent and independent variables.

Ethical Procedures

Both datasets were accessed from the ICPSR data sharing website. The participant identifying information had already been de-identified for participant protection. The de-identification of all participant information was pursuant to ICPSR data upload and

access policies. Restricted-use data sets are governed under the same de-identification requirements but require additional approval processes to be followed to access the data.

The Forces of Change Survey is restricted level 2 use; meaning data cannot be used for any purposes other than statistical reporting and analysis. This study was a statistical analysis of the existing survey data in combination with a second dataset. Restricted use policy from ICPSR was respected in this study. To access this restricted dataset IRB approval or notice of exemption for this study and a Restricted Data Use Agreement must be submitted per ICPSR policy. In addition, the application will need to include a project description, data security plan, and roster of research staff who will have access to the data including IT personal who might have access to the computer where the data will be stored.

The RAPID Survey did not require any additional approvals or data use agreements, outside the normal practices by ICPSR for de-identification of participant data. The standard data use agreement from ICPSR website was confirmed upon download of any dataset.

Walden University requires Institutional Review Board approval for all studies conducted as part of the doctoral programs and is necessary for this study. Walden IRB Form A was completed and submitted for ethics review and approval. After the IRB approved this study, the approval was submitted to the URR for review and approval.

Summary

This study was a quantitative secondary data analysis, combining two datasets by common independent variable “State.” Datasets used were the Forces of Change Survey

(ICPSR 37141) and the RAPID: Assessing the Variance, Effects, and Sources of Aversion to Zika Solutions. The dependent variables were ordinal, self-reported by individuals. The independent variables were nominal, self-reported by the LHDs. Ordered logistic regression analysis was performed to determine the relationship between the independent variables (level of engagement in prevention activities and level of engagement in education activities) and the dependent variables (individual risk perceptions and community risk perceptions). The ethical procedures required for this study included participant identity protections and IRB approval.

The results of this study determined the relationship between the LHDs level of engagement in prevention and education programs and their community's risk perceptions, at an individual and community level. The data collection methods used by the original researchers will be detailed in Chapter 4. Additionally, the results of the data analysis of the relationship between level of engagement in prevention and education and risk perceptions will be discussed in Chapter 4.

Chapter 4: Results

Introduction

The purpose of this quantitative study was to determine the relationship between local health departments' levels of engagement in plans for prevention and education, and individual-level perceived risks of Zika virus infection of the communities. This study addressed the following research questions and hypotheses:

RQ1: What is the relationship between public health department's level of engagement for prevention of Zika virus infection and the community's perception of risk of contracting the virus?

H_{01} – There is no statistically significant relationship between public health department's level of engagement for prevention of Zika virus infection and the community's perception of risk of contracting the virus.

H_1 – There is a statistically significance relationship between public health department's level of engagement for prevention of Zika virus infection and the community's perception of risk of contracting the virus.

RQ2: What is the relationship between public health department's level of engagement for community education on Zika virus and the community's perception of risk of contracting the virus?

H_{01} – There is no statistically significant relationship between public health department's level of engagement for community education on Zika virus and the community's perception of risk of contracting the virus.

H_1 – There is a statistically significant relationship between public health department's level of engagement for community education on Zika virus and the community's perception of risk of contracting the virus.

This chapter will address the data collection methods used by the researchers of the secondary datasets: Forces of Change Survey (NACCHO, 2017a) and RAPID Survey (Johnson, 2019a). The results of the secondary data analysis will be discussed in detail. Finally, this chapter will summarize the answers to the research questions.

Data Collection

The time frame for data collection for the RAPID Survey was from July 19, 2016, to April 23, 2017 (Johnson, 2019a). The RAPID Survey was conducted in four survey rounds (Johnson, 2019a); however, only the data from the first survey round was used for this study because the subsequent rounds of the study provided educational materials to the participants that would have skewed their knowledge and impacted their risk perceptions. The response rates for the RAPID Survey were 53.2% to 81.1% for surveys one through four, with an overall response rate of 73.7% from survey one to survey four (Johnson, 2019a). The time frame for data collection for the Forces of Change Survey was from February 21, 2017, to April 21, 2017 (NACCHO, 2017b). The Forces of Change Survey response rate was 65%, with 615 local health departments responding to the survey (NACCHO, 2017b).

There were 560 participants from the Forces of Change Survey, and all of them had a response for the variable "State" in the dataset. Prior to merging the two datasets, the RAPID Survey risk perception responses were averaged by "State" to merge in a one-

to-many relationship using SPSS, as there is no logic in place for many-to-many relationships. This resulted in a total of 45 cases from the RAPID Survey, after excluding data from states that were incomplete in either dataset. After cleaning and merging the two datasets, there remained a total of 560 participants in the working dataset.

All states except Hawaii, Rhode Island, Alaska, North Dakota, West Virginia, and Wyoming were represented in the merged dataset. Hawaii and Rhode Island do not have a local health department (LHD) representing their communities, and instead, are governed by the state health department (NACCHO, 2017a). Additionally, Alaska, North Dakota, West Virginia, and Wyoming were excluded from the merged dataset due to lack of response to the RAPID Survey risk perception questions and/or lack of responses to the level of engagement by LHD in prevention or education activities in the Forces of Change Survey.

The RAPID Survey was conducted by Decision Research using an online panel that consisted of a diverse recruitment of adults across genders, ages, and education levels, which was intended to be a representative sampling of adults in the United States (Johnson, 2019a). The data for the Forces of Change Survey was collected by NACCHO using online surveys sent to a random sampling of LHD contacts by NACCHO's president (NACCHO, 2017a). The RAPID Survey responses addressed the community risk perception, whereas the Forces of Change Survey responses addressed the local health departments' level of engagement in prevention and education activities related to Zika virus.

Results

Descriptive Statistics

The overall sample size was 560 participants. The variables for level of LHD engagement in prevention activities and level of LHD engagement in education activities were created as composites of survey questions regarding prevention and education activities. Composite scores ranged from 3 to 12, with levels 3 to 5 signifying high level of engagement, 6 to 8 signifying medium level of engagement, and 9 to 12 signifying low level of engagement. Most participants (58.4%) indicated a high level of engagement in prevention activities (Table 2). Additionally, most participants (76.6%) also indicated a high level of engagement in education activities (Table 2).

Table 2

Descriptive Statistics (N=560)

	Frequency	Percent
Level of Engagement in Prevention Activities		
High Prevention	327	58.4%
Medium Prevention	134	23.9%
Low Prevention	99	17.7%
Level of Engagement in Education Activities		
High Education	429	76.6%
Medium Education	91	16.3%
Low Education	40	7.1%
Risk Perception		
Low Risk	224	40.0%
High Risk	336	60.0%

The dependent variable, risk perception, was a composite of two survey questions about personal risk of Zika infection and the overall risk to the U.S. After recoding this

variable to be binomial, most respondents (60%) reported high risk perception of Zika infection (Table 2).

Statistical Assumptions

There are four assumptions that must be met to run an ordered, logistic regression analysis (Hosmer et al., 2013). The first is that there is one ordinal dependent variable (Hosmer et al., 2013); in this study, that variable was a composite variable of personal risk perception and U.S. risk perception from the RAPID Survey. The second is that there are one or more independent variables that are continuous, ordinal, or categorical (Hosmer et al., 2013). In this study, those variables were the composite variables for prevention activities and educational activities from the Forces of Change Survey. The third assumption is that there is no multicollinearity (Hosmer et al., 2013). For this study, multicollinearity was tested using SPSS's collinearity diagnostics. The independent variables showed no multicollinearity, with all tolerance values above 0.1. The fourth assumption is that there are proportional odds (Hosmer et al., 2013), which was tested using SPSS's Test of Parallel Lines. The assumption of proportional odds was violated, as assessed by a full likelihood ratio test comparing the fit of the proportional odds model to a model with varying location parameters, $\chi^2(144) = 456.465$, $p = <0.001$. Since the assumption of proportional odds was violated, ordinal logistic regression could not be performed, and instead multinomial logistic regression analysis was run in SPSS after the dependent variable was recoded to be binary. Multinomial logistic regression can be run when there are multiple independent variables and one binary dependent variable (Dawson & Trapp, 2004).

There are six assumptions that must be met to run a multinomial logistic regression analysis (Warner, 2013). The first is that the dependent variable is nominal (Warner, 2013); in this study, that variable was a composite variable of personal risk perception and U.S. risk perception from the RAPID Survey that was recoded to binomial risks of high and low. The second is that there is one or more independent variables, and they must be continuous, ordinal, or nominal (Warner, 2013). The third is that there is independence of observations, and the dependent variable has both mutually exclusive and exhaustive categories (Warner, 2013). The fourth is that there is no multicollinearity (Warner, 2013). The fifth is that there is a linear relationship between any continuous independent variables and the logit transformation of the dependent variable (Warner, 2013). The sixth is that there are no outliers in the data (Warner, 2013). The first three assumptions were confirmed prior to running the multinomial logistic regression analysis. Assumptions four through six were checked using SPSS.

Statistical Analysis Findings and Post-hoc Tests

A multinomial logistic regression analysis was performed in SPSS to overcome the proportional odds violation seen in the data. As a result, the data showed no statistical significance in the goodness-of-fit analysis, which indicated it was a good fit for the model, $\chi^2(4) = 3.571$, $p = 0.467$ (Table 3). The model explained 6.9% (Nagelkerke R^2) of the variance in risk perception and correctly classified 64.5% of cases. The likelihood ratio test indicated a statistical significance for the variables *Level of Engagement in Education Activities* and *Level of Engagement in Prevention Activities*; $p = 0.005$ and $p =$

0.023 (Table 4). Increased levels of engagement in education activities were associated with a decreased risk perception on contracting Zika virus.

Table 3

Goodness of Fit

	Chi-Square	df	Sig.
Pearson	3.571	4	0.467
Deviance	3.551	4	0.470

Table 4

Likelihood Ratio Tests

Effect	Model Fitting Criteria -2 Log Likelihood of Reduced Model	Likelihood Ratio Tests Chi-Square	df	Sig.
Intercept	28.332[a]	0.000	0	.
Engagement in Prevention Activities	45.866	7.533	2	0.023
Engagement in Education Activities	48.763	10.431	2	0.005

Note: The chi-square statistic is the difference in -2 log-likelihoods between the final model and a reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0.

The parameter estimates (Table 5) showed statistical significance for the relationship between the dependent variable, risk perception, and the independent variable, level of engagement in education activities. Specifically, there is statistical significance seen between low-risk perception and high level of engagement in education activities, $p = 0.004$. It is more likely that an individual would have a lower risk perception if they are residing in a community where the LHD had a high level of engagement in education activities than in an LHD where there was a low or medium level of engagement in education activities. Table 5 shows the regression analysis run on each risk perception level and each engagement level.

Table 5

Parameter Estimates

Risk Perception		B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B) Lower Bound	Upper Bound
Low Risk	Intercept	0.767	0.350	4.798	1	0.028			
	High Prevention	-0.455	0.265	2.957	1	0.085	0.634	0.377	1.066
	Medium Prevention	0.110	0.281	0.152	1	0.696	1.116	0.644	1.934
	Low Prevention	0	.	.	0	.	.	.	.
	High Education	-1.103	0.381	8.366	1	0.004	0.332	0.157	0.701
	Medium Education	-0.624	0.406	2.361	1	0.124	0.536	0.242	1.187
	Low Education	0	.	.	0	.	.	.	.

Note: The reference category is: High Risk.

Results of the multinomial logistic regression reveal, that for research question 1, there is no statistically significant relationship between local health departments' level of engagement for prevention of Zika virus infection and the community's perception of risk of contracting the virus; therefore, the null hypothesis is accepted.

For research question 2, there is a statistically significant relationship between local health departments' level of engagement for community education on Zika virus and the community's perception of risk of contracting the virus; therefore, the null hypothesis is rejected.

Summary

After a multinomial logistic regression analysis was performed the null hypothesis for the first research question was accepted and for the second was rejected. There is no statistically significant relationship between the local health departments' level of engagement in prevention activities and their community's risk perceptions of contracting

Zika virus. However, there is a statistically significant relationship between high level of engagement in education activities and low risk perception in the community. The interpretations of the findings and limitations of this study will be addressed in Chapter 5. Additionally, recommendations for further research and the implications of this study's results will be discussed.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The purpose of the study was to determine if there was a relationship between the local health departments' level of engagement in prevention and education activities, and their local communities' risk perceptions of contracting Zika virus. Two secondary datasets were merged using the common variable "State" to evaluate the relationship between these variables. The RAPID Survey contained survey questions related to risk perception in the community, and the Forces of Change Survey contained survey questions related to level of engagement in prevention and education activities. After merging the datasets, the relationship was evaluated to determine if there was a statistically significant association between level of engagement in prevention and education activities and community risk perceptions.

Local health department (LHD) prevention activities included in the prevention variable in this study were vector control to suppress Zika virus transmission, public health surveillance and epidemiological investigation, and conducting and/or coordinating lab testing (NACCHO, 2017a). LHD education activities included in the education variable in this study were providing information to travelers about Zika risks and protection measures, clinician outreach and communication on Zika clinical care guidelines, and risk communication/community education to inform the public about Zika virus and related illnesses (NACCHO, 2017a). The results of the multinomial logistic regression analysis revealed that there was no relationship between LHD level of engagement in prevention activities and community risk perceptions. The results also

indicated that there was a relationship between LHD level of engagement in education activities and community risk perceptions. Therefore, the null hypothesis for prevention activities was accepted, and the null hypothesis for education activities was rejected.

Interpretation of Findings

The findings of this study add to the current literature by investigating the relationship between the LHD's level of engagement in prevention and education activities related to Zika virus, and the local community's risk perceptions. The current literature identified relationships between residing in high-risk areas and having higher levels of risk perception (Johnson, 2018; Reynolds et al., 2019; Squiers et al., 2018; Winneg et al., 2018). This study did not evaluate residence location in the analysis but it would be expected to see higher risk perceptions in the communities that had higher levels of engagement in prevention and education; this is the case if we can assume the local health departments would have higher levels of engagement in those states (Johnson, 2018; Reynolds et al., 2019; Squiers et al., 2018; Winneg et al., 2018). Results of this study indicated that there was no significant relationship between LHD level of engagement in prevention activities and a community's risk perception; however, there was a relationship seen between high level of engagement in education activities and low level of risk perceptions in the community. Pogreba-Brown and colleagues (2020) determined there was greater concern over chronic health conditions than infectious diseases in certain high-risk communities, which led to lower risk perceptions and low prevention uptake. Additionally, there were no significant relationships seen between low level of engagement in education activities and low or high levels of risk perception. In a

study by Lo and Laurent-Simpson (2018) participants with higher socioeconomic status and higher education reported Zika virus infection risk as low, and in turn, reported lower engagement in preventive actions. The high engagement level in education activities by the LHD could have led to higher education levels in the community. If these same communities had higher socioeconomic levels, then we might mimic the Lo and Laurent-Simpson (2018) study results with high education leading to low-risk perceptions in the community.

Patel and colleagues (2019) found high levels of Zika virus knowledge were associated with high levels of engagement in preventive behaviors. In a separate study by Lo and Laurent-Simpson (2018), higher levels of education were associated with higher engagement in prevention behaviors, but lower risk perceptions. The current study also found high levels of engagement in LHD education activities were associated with lower levels of risk perception in the community. Higher education could be leading to lower levels of risk perception, if the community is receiving the educational information and interpreting their risk as low. An alternative explanation is that LHD education activities are not working to properly inform the community of their potential risk for Zika infection.

Interpretations Related to Health Belief Model

Rosenstock's health belief model details the factors influencing health behaviors and is the theoretical framework for this study (Rosenstock, 2005). In the HBM framework (Figure 1), cues to action must be larger or overcome an individual's perceived susceptibility, perceived seriousness, perceived barriers, and perceived benefits

to prompt self-efficacy or the desired health behavior (Rosenstock, 2005). Risk perception (perceived susceptibility) is one influencing factor for health behaviors identified by Rosenstock's health belief model (see Figure 1; Rosenstock, 2005).

Johnson (2018) found that residential location and psychological distance influenced an individuals' risk perception for contracting Zika Virus. The current study did not evaluate residence location or "State" as a confounder for the relationship between LHD engagement in prevention and education activities and risk perception. The significant relationship between high engagement in education and low risk perception could be explained by the HBM. When perceived susceptibility is low enough, the cue to action cannot trigger self-efficacy (Rosenstock, 2005). When looking at the HBM, the influencing factors act together to prompt self-efficacy, but when one factor, or many, are not overcome by the cues to action, then self-efficacy is not reached (Rosenstock, 2005). In the current study, low risk perception was seen when LHD engagement in education activities was high.

In response to the Zika virus outbreaks, health departments (including LHDs) developed prevention and education campaigns; however, many of these efforts were targeted at high-risk communities (Brooks et al., 2016; Capitulo, 2016; Shields, 2016). The targeted approach could explain the lower risk perceptions seen in this study when there was high engagement from the LHDs in education activities; this is the case if the lower risk perceptions can be attributed to low-risk areas that have not had targeted health campaigns. The types of education activities performed by the LHDs in this study included providing information to travelers about Zika risks and protection measures,

clinician outreach and communication on Zika clinical care guidelines, and risk communication/community education to inform the public about Zika virus and related illnesses (NACCHO, 2017a). The high level of engagement seen in the LHDs with lower risk perceptions could signify that these activities did not sufficiently increase the community's knowledge of Zika virus and properly inform their risk perceptions.

Zika infection rates have remained low in the United States, which has led to a lower perceived risk, even in states with the presence of Aedes mosquitos (Guerre-Reyes et al., 2018; Katler et al., 2017; Winneg et al., 2018). Even when individuals perceived a higher risk for the community or the United States as a whole, their personal risk perceptions remained low (Chandrasekaran et al., 2017). Avery and colleagues (2020) found that public health advisories impacted an individual's perceptions of preparedness, but not their personal risk perceptions. This study found a low perceived risk associated with LHDs that had a high level of engagement in education activities, which could be explained by low infection rates having led to low perceived risk and health advisories not impacting personal risk perceptions.

Limitations of the Study

A limitation to the current study that makes it not generalizable to the entire United States population is the lack of local health department participation on the Forces of Change Survey from the states of Hawaii and Rhode Island (NACCHO, 2017a.) These two states were not represented in the Forces of Change Survey dataset because they do not have local health departments (NACCHO, 2017a). Due to the small size of these states' populations, there are no established local health departments, and therefore,

public health issues are handled at the state level (NACCHO, 2017a). Only local health departments were interviewed for the Forces of Change Survey (NACCHO, 2017a). Even without these two states the authors of the Forces of Change Survey were able to conclude their findings as generalizable to the entire United States population (NACCHO, 2017a). Additional states – Alaska, North Dakota, West Virginia, and Wyoming - were excluded from this study due to incomplete responses to either set of survey questions. Due to these exclusions, the results of this study might not be generalizable to the populations in these states.

A second limitation to this study was the gender distribution of participants in the RAPID Survey. There were 60.6% of participants identified as female and 39.4% identified as male (Johnson, 2019a). The current United States gender distribution is 50.8% female and 49.2% male (U.S. Census Bureau, 2021). Seeing as Zika virus's serious adverse health outcomes focus mostly on unborn babies, the risk perceptions in this study could be skewed by having such a large participant pool of females compared to males. Although the authors of the RAPID Survey concluded their findings were generalizable to the entire United States population (Johnson, 2019a), to account for this skew in data, gender should be treated as a potential covariate and evaluated in this study.

A third limitation to the current study was the overlapping data collection periods for the two datasets. The RAPID survey was conducted from June 20, 2016, to April 23, 2017, and the Forces of Change Survey was conducted from February 21, 2017, to April 21, 2017 (Johnson, 2019a; NACCHO, 2017a). The Forces of Change Survey questions around Zika virus were asked about the current or most recent mosquito season in mind,

which could be prior to the actual survey period depending on the state (NACCHO, 2017a).

A final limitation to this study was the violation of the proportional odds assumption; required for ordinal logistic regression analysis to be performed (Hosmer et al., 2013). The full likelihood ratio test was performed to test the assumption of proportional odds. To overcome the limitation related to violating this assumption, the ordinal variables were recoded to categorical by combining levels into larger groups, and multinomial logistic regression analysis was performed. Additionally, risk perception was recoded to a binary variable in order to run multinomial logistic regression analysis, which changed the ability to investigate the varying levels of risk perception from the community.

Recommendations

Further research should be conducted to see how risk perceptions and health department engagement have changed given the newer pandemic facing the United States and the world. Zika virus has become less relevant considering the COVID-19 pandemic, even though the risk still exists in many areas for contracting Zika virus, especially as Aedes mosquitoes continue to be found in areas they previously did not inhabit. A new study on risk perceptions would need to be conducted and the most recent Forces of Change Survey could be used for the evaluation of the engagement of local health departments' prevention and education plans around Zika virus.

An additional recommendation would be to evaluate the additional methods of prevention and education activities included in the Forces of Change Survey to determine

if there is a relationship between those methods and the community risk perceptions represented in the RAPID Survey. The additional prevention and education activities included in the Forces of Change Survey include the following:

- Prevention of sexually transmitted Zika virus infections by educating the public and clinicians
- Prevention of blood transfusion transmitted Zika virus infections by testing blood products for Zika and investigating possible blood transfusion-transmitted Zika virus infections
- Maternal and child health surveillance and response to prevent and control Zika virus infections
- Rapid detection and follow-up of birth defects associated with Zika virus (NACCHO, 2017a)

Another recommendation would be to use the variable "State" as a confounder in an analysis of this relationship to see if there are increased risk perceptions related to residing in high-risk states, like those with outbreaks of Zika virus or the presence of Zika virus infected mosquitos. Additional studies could be conducted to determine if socioeconomic status impacts the risk perceptions in the community and possibly act as a confounder to the relationship between LHD education activities and risk perception. As indicated in the study by Lo and Laurent-Simpson (2018), higher socioeconomic status and education level led to lower risk perceptions of Zika virus infection. Several studies have determined a difference in risk perceptions based on community risk versus personal risk (Chandrasekaran et al., 2017; Johnson, 2018; Reynolds et al., 2019). An

additional analysis could be conducted to compare the personal risk perception RAPID Survey results to the U.S. risk perception. A qualitative study could be used to determine why there was low risk perception in communities that had high engagement by LHDs in education activities. A qualitative study could also look at the effectiveness of the education activities in improving the community's knowledge of Zika virus and how this impacts their risk perceptions.

Implications

The results of this study indicate there is no relationship between the level of engagement in the prevention activities and risk perception, and there is a relationship between high level of engagement in education activities and risk perception. The positive social change implications for public health departments are that this knowledge could inform the departments that their current methods are not impactful or there needs to be further funding to increase the LHD's ability to conduct additional prevention and education activities. The positive social change implications from an organizational perspective are that the current efforts studied to prevent Zika virus infection have no statistically significant relationship on risk perception in the community. Level of engagement as a measurement was a subjective term in the Forces of Change Survey, where respondents indicated their levels as "agree or have been engaged", "planning to engage", "neither engaged, nor planning to engage", or "not sure" and these were assigned numeric values for analysis (NACCHO, 2017a). The subjectivity in these responses could lead some LHDs to respond with high engagement that would equal low or moderate engagement levels in another state. In a high-risk state a "high" level of

engagement might look very different from a low-risk state "high" level of engagement. Since the response to Zika virus outbreaks is not standardized across states, there is room for variation in engagement by state, a more standardized response plan is warranted for uniformity across states (Blocker & Wilson, 2018).

Public health departments can use the results of this study to inform their plans for level of engagement in prevention and education activities related to Zika virus or other infectious diseases. The significant relationship between high level of engagement in education activities and low level of risk perception could signify the need to re-evaluate the education activities and how these messages are reaching the community. The logical assumption would have been to see higher risk perceptions correlated to higher levels of education (Lo & Laurent-Simpson, 2018); however, this study only evaluated the level of engagement and not the actual level of education or knowledge of Zika virus of the individuals. If the education activities are working to properly inform the public of their risks, we could be seeing a lower risk perception in states with no mosquito populations. The lack of relationship between level of engagement in prevention activities and community risk perception could indicate a lack of awareness from the community on Zika knowledge and efforts by the LHD to protect the community. Studies have shown that public health campaigns for Zika virus influenced the prevention behavior engagement by the public (Earle-Richardson et al., 2018; Juarbe-Rey et al., 2018; Moore, 2016). The type of public health campaign influenced the engagement in prevention behaviors across several studies (Earle-Richardson et al., 2018; Juarbe-Rey et al., 2018; Moore, 2016). If the public is more engaged in prevention behaviors, we might see lower

risk perceptions following the belief that the community is already doing everything to prevent infection, so the risk remains low.

Based on the results of this study, the recommendation to states with no Aedes mosquito populations would be to focus on educational efforts related to travelling to areas with Aedes mosquitos and Zika outbreaks as a prevention opportunity. The health message campaigns developed by many state health departments and LHDs have focused on the most vulnerable individuals as being the highest at risk, which has led to lower risk perceptions in individuals who are not part of that population (Chandrasekaran et al., 2017; Johnson, 2018; Reynolds et al., 2019). For states that have Aedes mosquito populations or Zika virus outbreaks the recommendation is to continue prevention activities and education activities, but to evaluate the effectiveness of the education activities in properly informing their communities of their individual risks, especially for individuals who are not pregnant or could become pregnant.

Conclusion

After evaluating the relationship between LHD level of engagement in certain prevention activities and education activities and community risk perception, there are a few things to note. High levels of engagement in education activities were significantly related to low levels of risk perception, however, low levels of education were not significantly related to high or low levels of risk perception. The high levels of engagement in education activities by the LHDs seems to have informed their communities about Zika virus and risks of contracting the virus; however, the low number of outbreaks has led to low risk perceptions (Chandrasekaran et al., 2017;

Johnson, 2018; Reynolds et al., 2019). Additionally, there was no statistically significant relationships seen between level of engagement in prevention activities at any level and either low or high level of risk perception. The lack of relationship between risk perception and prevention activities could indicate the need for standardized engagement plans at the LHDs (Blocker & Wilson, 2018).

To better respond to outbreak situations the LHDs need a standardized response plan that includes risk communications that target both the most vulnerable populations and the general community to ensure their communities can accurately assess their risks of contracting Zika virus. An assessment of the current prevention and education activities and materials content would ensure uniformity across LHDs to assist with proper communications to the public. The implications for social change for this study include informing LHDs about the need for comprehensive education activities that ensure appropriate levels of risk perception in their communities.

References

Adalja, A., Sell, T. K., McGinty, M., & Boddie, C. (2016). Genetically modified (GM) mosquito use to reduce mosquito-transmitted disease in the US: A community opinion survey. *PLoS Currents*, *8*. https://doi.org/10.1371/currents.outbreaks.1c39ec05a743d41ee39391ed0f2ed8d3

Ahrens, K., Hutcheon, J., Gavin, L., & Moskosky, S. (2017). Reducing unintended pregnancies as a strategy to avert Zika-related microcephaly births in the United States: A simulation study. *Maternal & Child Health Journal*, *21*(5), 982–987. https://doi.org/10.1007/s10995-017-2275-2

Alaali, Z. S., Longcore, N. D., Santos, P., Glaze, V. H., & Ahmad, N. (2020). Methods of tracking newborns: New York State Zika Pregnancy and Infant Registry, 2015–2017. *American Journal of Public Health, 110*(2), 216–221. https://doi.org/10.2105/AJPH.2019.305406

Allen, M. P. (2018). Chronicling the risk and risk communication by governmental officials during the Zika threat. *Risk Analysis: An International Journal*, *38*(12), 2507–2513. https://doi.org/10.1111/risa.13232

Avery, E. J., Kim, M., & Park, S. (2020). Self-efficacy and other considerations in performance of risk-reducing behaviors during a major disease outbreak. *Journal of Health Communication*. https://doi.org/10.1080/10810730.2020.1821131

Ayaz-Alkaya, S., Yaman-Sözbir, Ş., & Terzi, H. (2020). The effect of Health Belief Model-based health education programme on coping with premenstrual syndrome: A randomised controlled trial. *International Journal of Nursing*

Practice, *26*(2). https://doi.org/10.1111/ijn.12816

Basile, K., Kok, J., & Dwyer, D. E. (2017). Zika virus: what, where from and where to? *Pathology*, *49*(7), 698–706. https://doi-org.ezp.waldenulibrary.org/10.1016/j.pathol.2017.08.002

Berenson, A. B., Trinh, H. N., Hirth, J. M., Guo, F., Fuchs, E. L., Weaver, S.C. (2017). Knowledge and prevention practices among U.S. pregnant immigrants from Zika Virus outbreak areas. *American Journal of Tropical Medicine & Hygiene*, *97*(1), 155–162. https://doi.org/10.4269/ajtmh.17-0062

Blocker, J. & Wilson, D. R. (2018). Global perspective of infectious disease. *International Journal of Childbirth Education*, *33*(2), 45–47.

Brittain, A. W., August, E. M., Romero, L., Sheahan, M., Krashin, J., Ntansah, C., Honein, M. A., Jamieson, D. J., Ellis, E. M., Davis, M. S., & Lathrop, E. (2019). Community perspectives on contraception in the context of the Zika virus in the U.S. Virgin Islands: implications for communication and messaging. *Women's Health Issues*, *29*(3), 245–251. https://doi.org/10.1016/j.whi.2019.01.007

Brooks, J. T., Friedman, A., Kachur, R. E., LaFlam, M., Peters, P. J., & Jamieson, D. J. (2016). Update: Interim guidance for prevention of sexual transmission of Zika virus - United States, July 2016. *MMWR. Morbidity and Mortality Weekly Report*, *65*(29), 745–747. https://doi.org/10.15585/mmwr.mm6529e2

Byron, K., & Howard, D. (2017). "Hey everybody, don't get pregnant": Zika, WHO and an ethical framework for advising. *Journal of Medical Ethics*, *43*(5), 334. https://doi.org/10.1136/medethics-2016-103862

Calder, J. A. M. (2017). Zika virus in the Americas: Is it time to revisit mosquito elimination? *Journal of Environmental Health*, *80*(2), 26–27.

Callender, D. M. (2018). Factors contributing to and strategies to combat emerging arboviruses. *Global Public Health*, *13*(12), 1846–1852. https://doi.org/10.1080/17441692.2018.1464588

Capitulo, K. L. (2016). Interim guidelines for health care providers caring for pregnant women and women of reproductive age with possible Zika virus exposure - United States, 2016. *MCN: The American Journal of Maternal Child Nursing*, *41*(4), 256. https://doi.org/10.1097/NMC.0000000000000253

Centers for Disease Control and Prevention. (2019). *Microcephaly & Other Birth Defects*. Retrieved from https://www.cdc.gov/zika/healtheffects/birth_defects.html

Centers for Disease Control and Prevention. (2021). Zika virus: Case counts. Retrieved from https://www.cdc.gov/zika/reporting/index.html

Chan, M. S., Farhadloo, M., Winneg, K., Jamieson, K. H., Albarracin, D. (2018). Sources affecting knowledge and behavior responses to the Zika virus in US households with current pregnancy, intended pregnancy and a high probability of unintended pregnancy. *Journal of Public Health*, *40*(4), 776–786. https://doi.org/10.1093/pubmed/fdy085

Chan, M. S., Winneg, K., Hawkins, L., Farhadloo, M., Jamieson, K. H., & Albarracín, D. (2018). Legacy and social media respectively influence risk perceptions and protective behaviors during emerging health threats: A multi-wave analysis of

communications on Zika virus cases. *Social Science & Medicine*, *212*, 50–59. https://doi.org/10.1016/j.socscimed.2018.07.007

Chandrasekaran, N., Marotta, M., Taldone, S., & Curry, C. (2017). Perceptions of community risk and travel during pregnancy in an area of Zika transmission. *Cureus*, *9*(7), e1516. https://doi.org/10.7759/cureus.1516

Cunha, A., de Magalhães-Barbosa, M., Lima-Setta, F., Medronho, R., Prata-Barbosa, A. (2017). Microcephaly case fatality rate associated with Zika virus infection in Brazil. *The Pediatric Infectious Disease Journal*, *36*(5), 528-530. https://doi.org/10.1097/INF.0000000000001486

Daniel, K. L. (2016). Vital signs: Preparing for local mosquito-borne transmission of Zika virus - United States, 2016. *Morbidity and Mortality Weekly Report*, *65*(13), 352. https://doi.org/10.15585/mmwr.mm6513e1

Darrow, W., Bhatt, C., Rene, C., & Thomas, L. (2018). Zika virus awareness and prevention practices among university students in Miami: Fall 2016. *Health Education & Behavior*, *45*(6), 967–976. https://doi.org/10.1177/1090198118760687

Daughton, A. R., & Paul, M. J. (2019). Identifying protective health behaviors on Twitter: Observational study of travel advisories and Zika virus. *Journal of Medical Internet Research*, *21*(5), e13090. https://doi.org/10.2196/13090

Dawson, B. & Trapp, R. G. (2004). *Basic & Clinical Biostatistics* (4th ed.). McGraw-Hill Companies, Inc.

Dehlendorf, C., Gavin, L., Witt, J., & Moskosky, S. (2017). Facilitating state-wide

collaboration around family planning care in the context of Zika. *Women's Health Issues*, *27*(4), 392–399. https://doi.org/10.1016/j.whi.2017.03.011

Earle-Richardson, G., Prue, C., Turay, K., & Thomas, D. (2018). Influences of community interventions on Zika prevention behaviors of pregnant women, Puerto Rico, July 2016–June 2017. *Emerging Infectious Diseases*, *24*(12), 2251–2261. https://doi.org/10.3201/eid2412.181056

Ellingson, M., K., Bonk, C., M., & Chamberlain, A., T. (2017). A survey-based study of Zika virus communication preferences among pregnant women in Georgia, United States. *BMC Pregnancy and Childbirth*, *17*(1), 1–8. https://doi.org/10.1186/s12884-017-1516-0

Food and Drug Administration. (2019). *Zika virus response updates from FDA*. Retrieved from https://www.fda.gov/emergency-preparedness-and-response/mcm-issues/zika-virus-response-updates-fda

Grace-Leitch, L., & Shneyderman, Y. (2016). Using the Health Belief Model to examine the link between HPV knowledge and self-efficacy for preventive behaviors of male students at a two-year college in New York City. *Behavioral Medicine, 42*(3), 205–210. https://doi.org/10.1080/08964289.2015.1121131

Greer, S. L., & Singer, P. M. (2017). Addressing Zika in the United States: Polarization, fragmentation, and public health. *American Journal of Public Health, 107*(6), 861–862. https://doi.org/10.2105/AJPH.2017.303772

Guerra-Reyes, L., Fu, T., Williams, D., Herbenick, D., Dodge, B., Reece, M., & Fortenberry, J. (2018). Knowledge of Zika and perception of risk among sexually-

active adults in the United States of America: Results from a nationally representative sample. *PanAmerican Journal of Public Health, 42*, 1-9. https://doi.org/10.26633/RPSP.2018.43

Guidry, J. P. D., Carlyle, K. E., LaRose, J. G., Perrin, P., Ryan, M., Messner, M., & Adams, J. (2018). Framing and visual type: Effect on future Zika vaccine uptake intent. *Journal of Public Health Research, 7*(1). https://doi.org/10.4081/jphr.2018.1162

Guilford, K., McKinley, E., & Turner, L. (2017). Breast cancer knowledge, beliefs, and screening behaviors of college women: Application of the Health Belief Model. *American Journal of Health Education, 48*(4), 256–263. https://doi.org/10.1080/19325037.2017.1316694

Hatcher, R. A., Deal, M., Bowers, R., & Dickinson, J. (Eds.). (2016a). CDC updates guidance on Zika prevention. *Contraceptive Technology Update, 37*(12), 4–5.

Hatcher, R. A., Deal, M., Bowers, R., & Dickinson, J. (Eds.). (2016b). Get the latest guidance on Zika virus in the family planning setting. *Contraceptive Technology Update, 37*(10), 4–5.

Hatcher, R. A., Deal, M., Bowers, R., & Dickinson, J. (Eds.). (2016c). Zika Virus Update — What do your patients need to know? *Contraceptive Technology Update*, *37*(6), 61-63.

Hatcher, R. A., Deal, M., Bowers, R., Springston, J., Drachenberg, J., Mark, S., & Landenberger, L. (Eds.). (2017). Female condom important tool in Zika prevention. *Contraceptive Technology Update, 38*(4), 6–7.

Hatcher, R. A., Deal, M., Bowers, R., Springston, J., Drachenberg, J., Landenberger, L., & Brakman, A., Ellsworth, T.R. (Eds.). (2017b). New U.S. Zika figures prompt healthcare providers to play a key role in prevention efforts. *Contraceptive Technology Update, 38*(6), 61–63.

Heberlein-Larson, L., Gillis, L. D., Morrison, A., Scott, B., Cook, M., Cannons, A., Quaye, E., White, S., Cone, M., Mock, V., Schiffer, J., Lonsway, D., Petway, M., Otis, A., Stanek, D., Hamilton, J., & Crowe, S. (2019). Partnerships involved in public health testing for Zika virus in Florida, 2016. *Public Health Reports*, *134*(2), 43S–52S. https://doi.org/10.1177/0033354919867720

Heitzinger, K., Thoroughman, D. A., & Porter, K. A. (2018). Knowledge, attitudes, and practices of women of childbearing age testing negative for Zika virus in Kentucky, 2016. *Preventive Medicine Reports*, *10*(20–23), 20–23. https://doi.org/10.1016/j.pmedr.2018.01.002

Hills, S. L., Russell, K., Hennessey, M., Williams, C., Oster, A. M., Fischer, M., & Mead, P. (2016). Transmission of Zika virus through sexual contact with travelers to areas of ongoing transmission--continental United States, 2016. *Morbidity and Mortality Weekly Report*, *65*(8), 215. https://doi.org/10.15585/mmwr.mm6508e2

Hornstein, B. D., Olsen, E. P., Rubinstein, R. J., Jin, S., Zangeneh, A., Liu, L., & Shah, U. A. (2019). Provider and public health adaptation to changing Centers for Disease Control and Prevention guidance for Zika virus, 2015–2017. *American Journal of Public Health*, *109*(6), 895–898. https://doi.org/10.2105/AJPH.2019.305036

Hosmer, D. W., Lemeshow, S., & Sturdivant, R. X. (2013). *Applied Logistic Regression* (3rd ed.). John Wiley & Sons.

Howells, M. E., Lynn, C. D., Weaver, L. J., Langford-Sesepesara, M., & Tufa, J. (2018). Zika virus in American Samoa: challenges to prevention in the context of health disparities and non-communicable disease. *Annals of Human Biology*, *45*(3), 229–238. https://doi.org/10.1080/03014460.2018.1465594

Jaffe, E., Lyerly, A. D., & Goldfarb, I. T. (2020). Pregnant women's perceptions of risks and benefits when considering participation in vaccine trials. *Vaccine*, *38*(44), 6922–6929. https://doi.org/10.1016/j.vaccine.2020.08.059

Johnson, B. B. (2018). Residential location and psychological distance in Americans' risk views and behavioral intentions regarding Zika virus. *Risk Analysis*, *38*(12), 2561-2579. https://doi.org/10.1111/risa.13184

Johnson, B. B. (2019a). *RAPID: Assessing the variance, effects, and sources of aversion to Zika solutions* (Version V1) [Data set]. Inter-university Consortium for Political and Social Research [distributor]. https://doi.org/10.3886/E111624V1

Johnson, B. B. (2019b). Americans' views of voluntary protective actions against Zika infection: conceptual and measurement issues. *Risk Analysis: An International Journal*, *39*(12), 2694–2717. https://doi.org/10.1111/risa.13378

Juarbe-Rey, D., Pérez, A. O., Santoni, R. P. C. P., Ramírez, M. R., & Vera, M. (2018). Using risk communication strategies for Zika virus prevention and control driven by Community-Based Participatory Research. *International Journal of Environmental Research and Public Health*, *15*(11).

https://doi.org/10.3390/ijerph15112505

Juarez, J. G., Garcia-Luna, S., Medeiros, M. C. I., Dickinson, K. L., Borucki, M. K., Frank, M., Badillo-Vargas, I., Chaves, L. F., & Hamer, G. L. (2021). The eco-bio-social factors that modulate Aedes aegypti abundance in south Texas border communities. *Insects*, *12*(183), 183. https://doi.org/10.3390/insects12020183

Katler, Q., Godiwala, P., Macri, C., Pineles, B., Simon, G., Chang, A., & Ahmadzia, H. (2017). Evolution of knowledge, awareness, and practices regarding Zika virus from 2016 to 2017. *Infectious Diseases in Obstetrics and Gynecology*, *2017*, 6350602. https://doi.org/10.1155/2017/6350602

Krisberg, K. (2017). Zika: Public health on high alert as mosquito season begins. *American Journal of Public Health*, *107*(7), 1015. https://doi.org/10.2105/AJPH.2017.303849

Laurent-Simpson, A., & Lo, C. C. (2019). Risk society online: Zika virus, social media and distrust in the Centers for Disease Control and Prevention. *Sociology of Health & Illness*, *41*(7), 1270. https://doi.org/10.1111/1467-9566.12924

Lee, B., Alfaro-Murillo, J., Parpia, A., Asti, L., Wedlock, P., Hotez, P., & Glavani, A. (2017). The potential economic burden of Zika in the continental United States. *PLoS Neglected Tropical Diseases*, *11*(4), e0005531. https://doi.org/10.1371/journal.pntd.0005531

Lee, C. T., Greene, S. K., Baumgartner, J., & Fine, A. (2018). Disparities in Zika virus testing and incidence among women of reproductive age-New York City, 2016. *Journal of Public Health Management and Practice*, *24*(6), 533.

https://doi.org/10.1097/PHH.0000000000000684

Lee, C. T., Vora, N. M., Bajwa, W., Boyd, L., Harper, S., Kass, D., Langston, A., McGibbon, E., Merlino, M., Rakeman, J. L., Raphael, M., Slavinski, S., Tran, A., Wong, R., & Varma, J. K. (2016). Zika virus surveillance and preparedness – New York City, 2015-2016. *MMWR: Morbidity & Mortality Weekly Report*, *65*(24), 629–635. https://doi.org/10.15585/mmwr.mm6524e3

Lee, J., Kim, J. W., & Chock, T. M. (2020). From risk butterflies to citizens engaged in risk prevention in the Zika virus crisis: Focusing on personal, societal and global risk perceptions. *Journal of Health Communication*. https://doi.org/10.1080/10810730.2020.1836089

Lehnert, J. D., Ellingson, M. K., Goryoka, G. W., Kasturi, R., Maier, E., & Chamberlain, A. T. (2017). Use of Obstetric Practice Web Sites to Distribute Zika Virus Information to Pregnant Women During a Zika Virus Outbreak. *Journal of Public Health Management and Practice, 23*(6), 608–613. https://doi.org/10.1097/PHH.0000000000000537

Lein, D. H., Turner, L., & Wilroy, J. (2016). Evaluation of three osteoporosis prevention programs for young women: Application of the Health Belief Model. *American Journal of Health Education, 47*(4), 224–233. https://doi.org/10.1080/19325037.2016.1178610

Linde-Arias, A. R., Roura, M., & Siqueira, E. (2020). Solidarity, vulnerability and mistrust: how context, information and government affect the lives of women in times of Zika. *BMC Infectious Diseases*, *20*(1), 1–12.

https://doi/org/10.1186/s12879-020-04987-8

Lo, C. C., & Laurent-Simpson, A. (2018). How SES may figure in perceptions of Zika risks and in preventive action. *Sociological Spectrum, 38*(5), 295–311. https://doi.org/10.1080/02732173.2018.1502109

Lu, H. & Schuldt, J. P. (2018). Communicating Zika risk: Using metaphor to increase perceived risk susceptibility. *Risk Analysis, 38*(12), 2525-2534. https://doi.org/10.1111/risa.12982

Lull, R. B., Akin, H., Hallman, W. K., Brossard, D., & Jamieson, K. H. (2020). Modeling risk perceptions, and approval of releasing genetically engineered mosquitoes as a response to Zika virus. *Environmental Communication, 14*(7), 933-953. https://doi.org/10.1080/17524032.2019.1685558

Luquis, R. R., & Kensinger, W. S. (2019). Applying the Health Belief Model to assess prevention services among young adults. *International Journal of Health Promotion & Education, 57*(1), 37–47. https://doi.org/10.1080/14635240.2018.1549958

Marcell, V. & Spurlock, W. R. (2020). Beliefs and barriers towards flu vaccination among college students. *The Association of Black Nursing Faculty Journal, 31*(4), 108–112.

Matin, Z. S., Khayat, S., Navidian, A., & Fanaei, H. (2020). Comparing the effect of group training and telemedicine on exercise during pregnancy: An application of the health belief model. *Journal of Education and Health Promotion, 9*(1), 187. https://doi.org/10.4103/jehp.jehp_88_20

McDonald, J. A., Selchau, K., & Acquah-Baidoo, B. (2018). Scope of knowledge about Zika among women in US-Mexico border communities. *Journal of Community Health*, *43*(4), 705–716. https://doi.org/10.1007/s10900-018-0474-4

McNeill, C., Shreve, M. D., Jarrett, A., & Perry, C. (2016). Zika: What providers need to know. *The Journal for Nurse Practitioners*, *12*(6), 359–366. https://doi.org/10.1016/j.nurpra.2016.04.009

Miller, M., Banerjee, T., Muppalla, R., Romine, W., & Sheth, A. (2017). What are people tweeting about Zika? An exploratory study concerning its symptoms, treatment, transmission, and prevention. *JMIR Public Health and Surveillance*, *3*(2), e38. https://doi.org/10.2196/publichealth.7157

Moise I. K., Kangmennaang, J., Hutchings, T., Sheskin, I. M., & Fuller, D. O. (2018). Perceptions of Zika virus risk during 2016 outbreak, Miami-Dade County, Florida, USA. *Emerging Infectious Diseases*, *24*(7), 1379–1381. https://doi.org/10.3201/eid2407.171650

Moore, K. S. (2016). Assessing nurse practitioner knowledge of Zika virus. *The Journal for Nurse Practitioners*, *12*(10), 697–703. https://doi.org/10.1016/j.nurpra.2016.09.012

Moore, E., Rodriguez, X., Fernandez, D., Griffin, I., Fermin, M. E., Cap, N., & Zhang, G. (2019). Zika testing behaviors and risk perceptions among pregnant women in Miami-Dade County, one year after local transmission. *Maternal & Child Health Journal*, *23*(8), 1140–1145. https://doi.org/10.1007/s10995-019-02756-x

National Association of County & City Health Officials. (2017a). *Forces of change*

survey, United States, 2017, restricted-use level 2 data (ICPSR 37141; Version V1) [Data set]. Inter-university Consortium for Political and Social Research [distributor]. https://doi.org/10.3886/ICPSR37141.v1

National Association of County & City Health Officials. (2017b). *The changing public health landscape: Findings from the 2017 Forces of Change Survey* [PowerPoint slides]. https://www.naccho.org/uploads/downloadable-resources/2017-Forces-of-Change-Main-Report1.pdf

Nelson, E. J., Luetke, M. C., McKinney, C., & Omodior, O. (2019). Knowledge of the sexual transmission of Zika virus and preventive practices against Zika virus among U.S. travelers. *Journal of Community Health*, *44*(2), 377–386. https://doi.org/10.1007/s10900-018-0594-x

Nguyen-Truong, C. K. Y., Pedhiwala, N., Nguyen, V., Le, C., Le, T. V., Lau, C., Lee, J., & Lee-Lin, F. (2017). Feasibility of a multicomponent breast health education intervention for Vietnamese American immigrant women. *Oncology Nursing Forum*, *44*(5), 615–625. https://doi.org/10.1188/17.ONF.615-625

Noor, R. & Ahmed, T. (2018). Zika virus: Epidemiological study and its association with public health risk. *Journal of Infection and Public Health, 11*(5), 611-616. https://10.1016/j.jiph.2018.04.007

Onyegbule, P., Iyiegbuniwe, E., Sarter, B., & James, K. (Shadle). (2021). Evidence-based intervention program for reducing obesity among African-American women in Southern California. *Public Health Nursing*, *38*(3), 350–356. https://doi.org/10.1111/phn.12830

Ophir, Y. & Jamieson, K. H. (2018). Intentions to use a novel Zika vaccine: The effects of misbeliefs about the MMR vaccine and perceptions about Zika. *Journal of Public Health, 40*(4), e531–e537. https://doi.org/10.1093/pubmed/fdy042

Ophir, Y., & Jamieson, K. H. (2020). The effects of Zika virus risk coverage on familiarity, knowledge and behavior in the US – a time series analysis combining content analysis and a nationally representative survey. *Health Communication*, *35*(1), 35–45. https://doi.org/10.1080/10410236.2018.1536958

Oster, A. M., Brooks, J. T., Stryker, J. E., Kachur, R. E., Mead, P., Pesik, N. T., & Petersen, L. R. (2016). Interim guidelines for prevention of sexual transmission of Zika virus - United States, 2016. *MMWR. Morbidity and Mortality Weekly Report, 65*(5), 120–121. https://doi.org/10.15585/mmwr.mm6505e1

Oster, A. M., Russell, K., Stryker, J. E., Friedman, A., Kachur, R. E., Petersen, E. E., Jamieson, D. J., Cohn, A. C., & Brooks, J. T. (2016). Update: Interim guidance for prevention of sexual transmission of Zika virus--United States, 2016. *MMWR. Morbidity and Mortality Weekly Report, 65*(12), 323–325. https://doi.org/10.15585/mmwr.mm6512e3

Painter, J. E., Plaster, A. N., Tjersland, D. H., & Jacobsen, K. H. (2017). Zika virus knowledge, attitudes, and vaccine interest among university students. *Vaccine*, *35*(6), 960–965. https://doi.org/10.1016/j.vaccine.2016.12.050

Pan American Health Organization & World Health Organization. (2018). *Zika suspected and confirmed cases reported by countries and territories in the Americas Cumulative cases, 2015-2017*. Retrieved from

https://www.paho.org/hq/index.php?option=com_docman&view=download&category_slug=cumulative-cases-pdf-8865&alias=43296-zika-cumulative-cases-4-january-2018-296&Itemid=270&lang=en

Park, S., Boatwright, B., & Johnson Avery, E. (2019). Information channel preference in health crisis: Exploring the roles of perceived risk, preparedness, knowledge, and intent to follow directives. *Public Relations Review*, *45*(5). https://doi.org/10.1016/j.pubrev.2019.05.015

Patel, N., Anees, M., Kola, R., Acuña, J., Rodriguez de la Vega, P., Castro, G., Ruiz, J. G., & Rojas, P. (2019). Association between knowledge of Zika transmission and preventative measures among Latinas of childbearing age in farm-working communities in South Florida. *International Journal of Environmental Research and Public Health*, *16*(7). https://doi.org/10.3390/ijerph16071257

Petersen, E. E., Meaney-Delman, D., Neblett-Fanfair, R., Havers, F., Oduyebo, T., Hills, S. L., Rabe, I. B., Lambert, A., Abercrombie, J., Martin, S. W., Gould, C. V., Oussayef, N., Polen, K. N. D., Kuehnert, M. J., Pillai, S. K., Petersen, L. R., Honein, M. A., Jamieson, D. J., & Brooks, J. T. (2016). Update: Interim guidance for preconception counseling and prevention of sexual transmission of Zika virus for persons with possible Zika virus exposure - United States, September 2016. *MMWR: Morbidity & Mortality Weekly Report*, *65*(39), 1077–1081. https://doi.org/10.15585/mmwr.mm6539e1

Philip, C., Novick, C. G., & Novick, L. F. (2019). Local transmission of Zika virus in Miami-Dade County: The Florida Department of Health rises to the challenge.

Journal of Public Health Management and Practice, *25*(3), 277. https://doi.org/10.1097/PHH.0000000000000990

Piltch-Loeb, R., Abramson, D. M., & Merdjanoff, A. A. (2017). Risk salience of a novel virus: US population risk perception, knowledge, and receptivity to public health interventions regarding the Zika virus prior to local transmission. *PLoS ONE*, *12*(12), 1–12. https://doi.org/10.1371/journal.pone.0188666

Piltch-Loeb, R., Merdjanoff, A. A., Bhanja, A., & Abramson, D. M. (2019). Support for vector control strategies in the United States during the Zika outbreak in 2016: The role of risk perception, knowledge, and confidence in government. *Preventive Medicine*, *119*, 52–57. https://doi.org/10.1016/j.ypmed.2018.12.019

Plaster, A. N., Painter, J. E., Tjersland, D. H., & Jacobsen, K. H. (2018). University students' knowledge, attitudes, and sources of information about Zika virus. *Journal of Community Health*, *43*(4), 647–655. https://doi.org/10.1007/s10900-017-0463-z

Poehlman, J. A., Sidibe, T., Jimenez-Magdaleno, K. V., Vazquez, N., Ray, S. E., Mitchell, E. W., & Squiers, L. (2019). Developing and testing the Detén El Zika Campaign in Puerto Rico. *Journal of Health Communication*, *24*(12), 900–911. https://doi.org/10.1080/10810730.2019.1683655

Pogreba-Brown, K., Austhof, E., Okello, A., Weiss, J., Lira, R., & Ernst, K. (2020). Public perceptions of non-pharmaceutical interventions for influenza and mosquito-borne illnesses - a statewide survey in Arizona. *Perspectives in Public Health*, *140*(4), 214–221. https://doi.org/10.1177/1757913919886605

Polen, K. D., Gilboa, S. M., Hills, S., Oduyebo, T., Kohl, K. S., Brooks, J. T., Adamski, A., Simeone, R. M., Walker, A. T., Kissin, D. M., Petersen, L. R., Honein, M. A., & Meaney-Delman, D. (2018). Update: Interim guidance for preconception counseling and prevention of sexual transmission of Zika virus for men with possible Zika virus exposure - United States, August 2018. *MMWR: Morbidity & Mortality Weekly Report*, *67*(31), 868–871. https://doi.org/10.15585/mmwr.mm6731e2

Prue, C. E., Roth Jr., J. N., Garcia-Williams, A., Yoos, A., Camperlengo, L., DeWilde, L., Lamtahri, M., Prosper, A., Harrison, C., Witbart, L., Guendel, I., Wiegand, D. M., Lamens, N. R., Hillman, B., Davis, M. S., Ellis, E. M., Roth, J. N., Jr, & Hillman, B. (2017). Awareness, beliefs, and actions concerning Zika virus among pregnant women and community members - U.S. Virgin Islands, November-December 2016. *MMWR: Morbidity & Mortality Weekly Report*, *66*(34), 909–913. https://doi.org/10.15585/mmwr.mm6634a4

Reynolds, T. L., Gui, X., Chen, Y., & Zheng, K. (2019). Understanding U.S. adults' Zika virus risk perceptions and mitigation behaviors to improve technology-supported risk communication. *Studies in Health Technology and Informatics*, *264*, 1874–1875. https://doi.org/10.3233/SHTI190691

Ros, S. T. (2018). Zika news, cautions and precautions for 2018: Media attention to Zika may have dwindled but ob/gyns need to remain vigilant in counseling patients. *Contemporary OB/GYN*, *63*(5), 12–13.

Rosenstock, I. M. (2005). Why people use health services. *The Milbank Quarterly*, *83*(4).

Santibanez, S., Lynch, J., Paye, Y. P., McCalla, H., Gaines, J., Konkel, K., Torres, L. J. O., North, W. A., Likos, A., & Daniel, K. L. (2017). Engaging community and faith-based organizations in the Zika response, United States, 2016. *Public Health Reports, 132*(4), 436. https://doi.org/10.1177/0033354917710212

Seidlein, L., Kekulé, A.S., & Strickman, D. (2017). Novel vector control approaches: The future for prevention of Zika virus transmission? *PLoS Medicine, 14*(1), e1002219. https://doi.org/10.1371/journal.pmed.1002219

Sell, T. K., Ravi, S. J., Watson, C., Meyer, D., Pechta, L. E., Rose, D. A., Lubell, K. M., Podgornik, M. N., & Schoch-Spana, M. (2020). A public health systems view of risk communication about Zika. *Public Health Reports*, *135*(3), 343–353. https://doi.org/10.1177/0033354920912215

Sell, T. K., Watson, C., Meyer, D., Kronk, M., Ravi, S., Pechta, L. E., Lubell, K. M., & Rose, D. A. (2018). Frequency of risk-related news media messages in 2016 coverage of Zika virus. *Risk Analysis: An International Journal*, *38*(12), 2514–2524. https://doi.org/10.1111/risa.12961

Shields, W. (2016). Pregnancy Prevention Toolkit helps prevent spread of Zika virus. *Contraceptive Technology Update*, *37*(9), 97–99.

Shreve, M., Jarrett, A., Scott, A. L., & McNeill, C. (2019). Zika: An unfolding story. *The Journal for Nurse Practitioners, 15*(6), 410–414. https://doi-org.ezp.waldenulibrary.org/10.1016/j.nurpra.2018.11.010

Smoots, A., Olson, S., Cragan, J., Delaney, A., Roth, N., Godfred-Cato, S., …, Honein, M. (2020). Population-Based Surveillance for Birth Defects Potentially Related to

Zika Virus Infection — 22 States and Territories, January 2016–June 2017. *MMWR Morbidity and Mortality Weekly Report, 69*, 67–71. Doi: http://dx.doi.org/10.15585/mmwr.mm6903a3

Sommariva, S., Vamos, C., Mantzarlis, A., Đào, L. U.-L., & Martinez Tyson, D. (2018). Spreading the (fake) news: Exploring health messages on social media and the implications for health professionals using a case study. *American Journal of Health Education, 49*(4), 246–255. https://doi.org/10.1080/19325037.2018.1473178

Squiers, L., Herrington, J., Kelly, B., Bann, C., Becker-Dreps, S., Stamm, L., Johnson, M., & McCormack, L. (2018). Zika virus prevention: U.S. travelers' knowledge, risk perceptions, and behavioral intentions-A national survey. *The American Journal of Tropical Medicine and Hygiene, 98*(6), 1837–1847. https://doi.org/10.4269/ajtmh.17-0898

Squiers, L., Lynch, M., Dolina, S., Ray, S., Kelly, B., Herrington, J., Turner, M., Chawla, D., Becker-Dreps, S., Stamm, L., & McCormack, L. (2019). Zika and travel in the news: a content analysis of US news stories during the outbreak in 2016–2017. *Public Health (Elsevier), 168*, 164–167. https://doi.org/10.1016/j.puhe.2018.12.009

Sridhar, S., Régner, I., Brouqui, P., & Gautret, P. (2016). Methodologies for measuring travelers' risk perception of infectious diseases: A systematic review. *Travel Medicine and Infectious Disease, 14*(4), 360-372. https://doi.org/10.1016/j.tmaid.2016.05.012

Summer, J. (2003). *Quantitative and qualitative paradigm assumptions*. Retrieved from https://academicguides.waldenu.edu/ld.php?content_id=57291599

Sundstrom, B., Brandt, H. M., Gray, L., & Pierce, J. Y. (2018). It's My Time: Applying the health belief model to prevent cervical cancer among college-age women. *Journal of Communication Management, 22*(2), 161–178. https://doi.org/10.1108/JCOM-06-2016-0044

Thompson, E. L., Vamos, C. A., Jones, J., Liggett, L. G., Griner, S. B., G. Logan, R., & Daley, E. M. (2018). Perceptions of Zika virus prevention among college students in Florida. *Journal of Community Health*, *43*(4), 673–679. https://doi.org/10.1007/s10900-018-0468-2

Tizzoni, M., Panisson, A., Paolotti, D., & Cattuto, C. (2020). The impact of news exposure on collective attention in the United States during the 2016 Zika epidemic. *PLoS Computational Biology*, *16*(3), 1–18. https://doi.org/10.1371/journal.pcbi.1007633

Toppenberg-Pejcic, D., Noyes, J., Allen, T., Alexander, N., Vanderford, M., & Gamhewage, G. (2019). Emergency risk communication: Lessons learned from a rapid review of recent gray literature on Ebola, Zika, and Yellow Fever. *Health Communication*, *34*(4), 437–455. https://doi.org/10.1080/10410236.2017.1405488

U.S. Census Bureau. (2021). QuickFacts: United States. Retrieved from https://www.census.gov/quickfacts/fact/table/US/SEX255220

Vasquez, A. M., Sapiano, M. R. P., Basavaraju, S. V., Kuehnert, M. J., & Rivera-Garcia, B. (2016). Survey of blood collection centers and implementation of guidance for

prevention of transfusion-transmitted Zika virus infection--Puerto Rico, 2016. *MMWR: Morbidity & Mortality Weekly Report*, *65*(14), 375–378. https://doi.org/10.15585/mmwr.mm6514e1

Vielot, N. A., Stamm, L., Herrington, J., Squiers, L., Kelly, B., McCormack, L., & Becker-Dreps, S. (2018). United States travelers' concern about Zika infection and willingness to receive a hypothetical Zika vaccine. *American Journal of Tropical Medicine & Hygiene*, *98*(6), 1848–1856. https://doi.org/10.4269/ajtmh.17-0907

Voelker, R. (2016). Miami obstetrician uses evidence to quell Zika fears. *JAMA*, *315*(19), 2051–2052. https://doi.org/10.1001/jama.2016.4069

Voelker, R. (2017). Virgin Islands' Zika Awareness. *Journal of The American Medical Association*, *318*(14), 1315. https://doi.org/10.1001/jama.2017.14435

Vos, S. C., Sutton, J., Yu, Y., Renshaw, S. L., Olson, M. K., Gibson, C. B., & Butts, C. T. (2018). Retweeting risk communication: The role of threat and efficacy. *Risk Analysis: An International Journal*, *38*(12), 2580–2598. https://doi.org/10.1111/risa.13140

Warner, R. M. (2013). *Applied Statistics: From Bivariate Through Multivariate Techniques* (2nd ed.). SAGE Publications, Inc.

Wetzel, L. M. (2017). Update to Zika care standards. *Contemporary OB/GYN*, *62*(8), 39.

Winneg, K. M., Stryker, J. E., Romer, D., & Jamieson, K. H. (2018). Differences between Florida and the rest of the United States in response to local transmission of the Zika virus: Implications for future communication campaigns. *Risk*

Analysis: An International Journal, *38*(12), 2546–2560. https://doi.org/10.1111/risa.13010

Wirz, C. D., Mayorga, M., & Johnson, B. B. (2020). A longitudinal analysis of Americans' media sources, risk perceptions, and judged need for action during the Zika outbreak. *Health Communication*. https://doi.org/10.1080/10410236.2020.1773707

Wirz, C. D., Xenos, M. A., Brossard, D., Scheufele, D., Chung, J. H., & Massarani, L. (2018). Rethinking social amplification of risk: Social media and Zika in three languages. *Risk Analysis: An International Journal*, *38*(12), 2599–2624. https://doi.org/10.1111/risa.13228

Wishner, C., Taylor, C., Leigh, L., Williams, M., Bell, M. A., & Luebke, S. (2020). Physician Assistant students' knowledge of Zika virus: A pilot study. *Infectious Diseases*, *13*. https://doi.org/10.1177/1178633720909158

Wisner, K. (2020). The Zika virus and childbearing women. *The American Journal of Maternal Child Nursing*, *45*(1), 59. https://doi.org/10.1097/NMC.0000000000000587

World Health Organization. (2019). *Zika epidemiology update*. Retrieved from https://www.who.int/docs/default-source/documents/emergencies/zika/zika-epidemiology-update-july-2019a39b932856a442cdb5330c90a5675fd5.pdf?sfvrsn=ea726540_1&download=true

Yang, C., Dillard, J. P., & Li, R. (2018). Understanding fear of Zika: Personal,

interpersonal, and media influences. *Risk Analysis: An International Journal*, *38*(12), 2535–2545. https://doi.org/10.1111/risa.12973

Zare, M., Ghodsbin, F., Jahanbin, I., Ariafar, A., Keshavarzi, S., & Izadi, T. (2016). The effect of Health Belief Model-based education on knowledge and prostate cancer screening behaviors: A randomized controlled trial. *International Journal of Community Based Nursing and Midwifery*, *4*(1), 57–68. https://doaj.org/article/6bcc1af88117482093eb0d6d0164d795

Zhou-Talbert, S. S., Lee, S. Y., Vielot, N. A., Silver, A. C., Anna, J., Webster, C. R., & Becker-Dreps, S. (2020). Awareness, knowledge, and travel-related risk factors for Zika virus among Latinas attending a federally qualified health center in rural North Carolina. *North Carolina Medical Journal*, *81*(1), 14–22. https://doi.org/10.18043/ncm.81.1.14