DISASTERS, PREGNANCY, AND MENTAL HEALTH: A SECONDARY DATA

ANALYSIS OF THE PREGNANCY RISK ASSESSMENT MONITORING SYSTEM-ZIKA

POSTPARTUM EMERGENCY RESPONSE (PRAMS-ZPER) STUDY OF POSTPARTUM

WOMEN IN PUERTO RICO

by

SHERRI HANCEL LIVINGSTONE

(Under the Direction of José F. Cordero)

ABSTRACT

Background: Climate-related disasters such as hurricanes, and emerging diseases, such

as Zika, are increasing worldwide. The resulting impact may place vulnerable populations

including pregnant and postpartum women at an increased risk of adverse outcomes such as

depression and other mental health conditions. We examine the effects of disasters on mental

health and disaster planning among women delivering a live birth in Puerto Rico post-Hurricanes

Irma and the Zika outbreak.

Methods: We used data from the 2017 PRAMS-ZPER 2.0 study, conducted in Puerto

Rico post Hurricanes Irma and Maria to conduct two related analyses. The first assessed

exposures to hurricanes and self-reported feelings of depression postpartum among pregnant

women who recently had a live birth. The second examined associations between engagement in

Zika preventative measures and hurricane disaster preparedness planning. Eligible participants

were women who delivered a livebirth in hospitals in Puerto Rico during the study period. Sampling for the study was planned in a representative sampling of health regions in Puerto Rico.

Results: Overall, 1,230 participants were included in this analysis. In the first study, which assessed hurricane experiences during pregnancy and postpartum depressive symptoms and lack of interest, depressive symptoms were common, with 20% of study participants reporting depressive symptoms always or sometimes. Individuals experiencing 1-2 life-threatening hurricane events and disruption in their housing had an increased likelihood of sometimes experiencing depressive symptoms. The second study found that women who engaged in certain Zika precautionary measures had a higher likelihood of engaging in adequate hurricane disaster planning.

Conclusion: Pregnant women who experienced hurricane disasters were more likely to report experiencing postpartum depressive symptoms. Hence, the engagement in disaster planning and identifying signs of depression post-pregnancy post-disaster may help mitigate the risk and aid in identifying optimal care for pregnant and postpartum women most at risk for adverse mental health outcomes in post-disaster environments.

INDEX WORDS: Postpartum Depression, Disasters, Postpartum Mental Health, Hurricanes, Zika Virus, Puerto Rico, Disaster Preparedness, Post-Disaster Planning

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SHERRI HANCEL LIVINGSTONE

B.A., City University of New York Brooklyn College, 2000

M.P.A., University of Georgia, 2006

M.P.H, University of Georgia, 2013

A Dissertation Submitted to the Graduate Faculty of The University of Georgia in Partial

Fulfillment of the Requirements for the Degree

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SHERRI HANCEL LIVINGSTONE

Major Professor: José F. Cordero
Committee: Ye Shen
                   Andrea Swartzendruber
                   Lee Warner

Electronic Version Approved:

Ron Walcott
Vice Provost for Graduate Education and Dean of the Graduate School
The University of Georgia
August 2022

DEDICATION

I dedicated this work to the lord that strengthens me!

To my loving husband, Mitch Livingstone who never stopped believing in me and supporting me every step of the way. Thanks for being my best friend and supporting all my dreams without question or doubt. Love you more than words can say!

To my two wonderful boys, August and Haven who stayed up by my side so many countless nights and reheated my tea. Thanks for your patience and understanding as you took this journey with me.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION AND LITERATURE REVIEW

DISASTER PREPAREDNESS AND POSTPARTUM MENTAL HEALTH

1.1 Overview

This study examines a range of topics impacting pregnant and postpartum women in post-disaster environments. Specifically, this work investigates post-disaster mental health depression associated with adverse experiences from hurricanes Irma and Maria in Puerto Rico. Subsequently, it examines disaster planning efforts related to the influence of Zika precautionary measures on hurricane disaster planning. To achieve this, we utilized survey data from the Pregnancy Risk Assessment Monitoring System – Zika Postpartum Emergency Response, Version 2 (PRAMS-ZPER. 2.0) study conducted in Puerto Rico by the Centers for Disease Control and Prevention (CDC) and the Puerto Rico Department of Health from 2017- 2018. The PRAMS-ZPER 2.0 occurred across two phases, a hospital-based survey, and a telephone follow-up survey.

The PRAMS-ZPER 2.0 data provided a unique opportunity to investigate the behaviors and attitudes of pregnant women in Puerto Rico related to the Zika virus outbreak in combination with the experiences of Hurricanes Irma and Maria. This dataset provided empirical data on converging disasters during a challenging period and a unique opportunity to investigate hurricane experiences and outcomes among the pregnant population. It was an extraordinary research opportunity that, to our knowledge, has not been experienced before.

1.2 Organization of Study

Chapter 1 of this dissertation details the literature review relevant to understanding a range of issues related to disaster occurrence and its impact on pregnant and postpartum mental health, depression, including disaster preparedness planning and resilience, and identified gaps in the literature. Chapter 2 provides an overview of the methods, detailing the dataset used for this study, a description of the variables, and a statistical analysis plan. Chapters 3 and 4 were written in a manuscript-style format. Each stands along with an abstract, introduction, methods, results, discussion, and conclusion. Chapter 5 summarizes the discussion of both manuscripts, followed by references. An overview of the manuscripts is as follows:

Chapter 3. The Association of Negative Hurricane Experiences on Self-Reported Feelings of Depression and Loss of Interest Among Postpartum Women in Puerto Rico.

The prevalence of postpartum depression has been well documented within the literature. However, studies on feelings of depression during the postpartum period in post-disaster environments are limited. The most notable studies investigated hurricane experiences, depression, and post-traumatic stress disorder following Hurricane Katrina in New Orleans (Harville 2010, Ehrlick 2010). For this study, we explored a similar relationship between hurricane experiences and reported feelings of depression during the postpartum period following Hurricanes Irma and Maria in Puerto Rico. We hypothesized that postpartum women that experienced an increased number of hurricane events or stressors as reported by damage sustained to personal property, walking through floodwaters, loss of family members, loss of water, and electricity, among other experiences, are associated with self-reported postpartum depressive symptoms and having a lack of interest in daily activities.

Chapter 4: Association of Zika Precautionary Measures and the Engagement in Hurricane Disaster Planning Among Pregnant Women in Puerto Rico

Climate-related disasters and epidemics are now commonplace, and preparedness is vital to ensuring resilience among individuals within the community (WHO 2004). This study investigates the relationship between preparedness measures taken during one disaster and the likelihood of impacting precautions or preparedness during another. Specifically, we investigated the association of actions taken by pregnant women to prevent Zika infection and the related engagement in hurricane disaster planning before Hurricanes Irma and Maria in Puerto Rico. We hypothesized that engagement in Zika precautionary measures is associated with engagement in hurricane disaster preparedness planning before Hurricanes Irma and Maria.

1.3 Background: Disaster Strikes Puerto Rico

The 21st Century has emerged as a time of major natural disasters, both from climate-related events and epidemics. In the climate realm, there has been an increase in the frequency and intensity of hurricanes in the Atlantic and typhoons in the Pacific, leading to high mortality and social disruption. Severe droughts have led to devastating fires in the United States, Europe, and Australasia (NASA 2021). These climatic events have overlapped with major outbreaks of Ebola, and Zika, culminating with the current COVID-19 pandemic. So was the case for Puerto Rico, hit in 2016 with the outbreak of the Zika virus followed in 2017 with Hurricanes Irma and Maria within two weeks.

In early 2016, the emergence of the Zika virus in Puerto Rico led to the largest outbreak in a U.S. territory. It continued into the summer of 2017, followed by back-to-back hurricane disasters. The Zika virus is the first recognized vector-borne infection to causes severe fetal

abnormalities resulting from maternal infection spreading through bites of the *Aedes* mosquitoes (Pastula 2016).

Zika made its way through several Pacific Ocean islands, from Yap, Micronesia, and other South Pacific islands in late 2000 (Duffy 2009, WHO 2016). In 2015, the virus rapidly spread from South America to Central America, Mexico, the Caribbean, and Puerto Rico (Pastula 2016). While Zika virus infection may often be asymptomatic, including pregnant women, it can severely affect the developing fetus, leading to adverse pregnancy outcomes, including microcephaly, other severe congenital and developmental disabilities, and adverse pregnancy outcomes (Brasil 2016, CDC 2020a).

Puerto Rico was hardest U.S. jurisdiction hit by the Zika virus, reporting over 35,000 cases, with more than 3,300 confirmed infections among pregnant women (CDC 2016, Dept of Salud 2017). With no vaccines or countermeasures to prevent mother-to-child transmission, interventions focused on limiting mosquito bites in pregnant women. Other strategies aimed at reducing unintended pregnancies that accounted for 66% of pregnancies in Puerto Rico compared to 51% in the United States (Earle-Richardson, 2018 Tepper 2016, Hamilton 2015). Joint efforts by the CDC Foundation and the Puerto Rico Department of Health launched the Zika Contraception Access Network (Z-CAN), an initiative to delay or prevent pregnancy by providing a variety of contraceptives to women at no cost (CDCF, 2018)

Additional programs to minimize infections included "Detén el Zika/ Stop Zika," a media campaign providing information on removing standing water, proper usage of larvicide, and other methods to interrupt viral transmission (CDCF 2016, CDCF 2020). Women, Infants, and

Children (WIC) clinics provided Zika informational videos and free mosquito spraying services upon request. The Puerto Rico Department of Health distributed Zika prevention kits that included repellent, larvicide, bed nets, and condoms (HHS 2016, Earle-Richardson 2018). Evaluation to assess uptake of behavior modification efforts showed 90% participation in removing standing water, but the installation of window or door screens was at a low 18%. Application of larvicide had a lower uptake at 13% but increased over time to 40% (Earle-Richardson 2018).

1.4 Hurricanes Irma and Maria Hit Puerto Rico

In September 2017, still battling the Zika virus, two class 4 hurricanes, Irma, and Maria, hit Puerto Rico within two weeks of each other (Sullivan 2018, Emery 2021). Hurricane Maria made landfall in Dominica, the Virgin Islands, and then Puerto Rico with catastrophic winds and flooding (NWS 2018). The devastation to crucial infrastructure from waist-deep sewage-ridden floodwaters left many without access to basic food, clean water, and essential supplies (Kishore 2018). It became the worst natural disaster recorded in the Caribbean, with estimated damages exceeding $90 billion (Meyer 2018, Rudner 2018, Hersher 2019).

The devastation of the hurricane was further complicated by initial underestimates about the hurricane-associated mortality (Santos, 2018; Riviera, 2018). Initially, government officials reported a death toll of 64, but it was scrutinized as a gross underrepresentation of the disaster's true impact. A study examining the death toll, conducted by investigators at the George Washington University reported 1,205 excess deaths in September and October 2017 compared to years prior (Santos-Lozada 2020). Another study from Harvard T.H. Chan School of Public

Health estimated that the deaths from September 20th to December 31st, 2017, surpassed 4,645, a 61% increase over the same period in 2016 (Kishore 2018).

Figure 1.1 The Path of Hurricane Maria in Puerto Rico
Source: U.S. National Oceanic and Atmospheric Administration

1.5 Disaster Psychological Health

Disasters have been associated with an increased risk of post-traumatic stress, anxiety, and depression (Bevilacqua, 2019, Fergusson, 2014). Following Hurricane Maria, Puerto Rico's government-ran suicide hotline reported over 3,000 crisis calls between November 2017 and January 2018, three times greater than what was received during the same time the previous year (Milligan 2018). Disasters of this magnitude disproportionately impact the most vulnerable population, the poor, the socially isolated, ethnic minorities, and women in society, including those who are pregnant and postpartum (WHO 2002, Runkle 2012).

During pregnancy, women face many challenges, from pregnancy-related illnesses and complications and, again, during the postpartum period experiencing increased levels of stress, fatigue, and the risk of Postpartum Depression (PPD) (Harville 2009, O'Brien 1998, Runkle 2012). Women delivering during a hurricane, when coupled with the events of a disaster,

magnifies the challenges and health risks pregnant and postpartum women face, from the lack of access to food, clean water, medical supplies, and sanitary conditions to the deterioration in the physical environment and medical infrastructure (Zotti 2012, Harville 2009, WHO 2014). Such devastation can exacerbate an already stressful situation as they recover from childbirth, cope with fatigue, and manage their overall emotional and physical well-being (Corrarino 2008, Xiong 2010, Shooshtari 2018).

Under normal circumstances,10-16% of women of reproductive age are at risk for PPD (Sherman 2018, Bauman 2018), a condition described as the onset of minor to significant depressive symptoms occurring up to a year post-delivery with symptoms of sadness, anxiety, guilt, or irritability that impede the mother's ability to care for herself or others (ACOG 2019, APA 2020). Clinical diagnosis of PPD is conducted through structured interviews; however, self-reported assessment is often used as a surrogate in many field studies (O'Hare 2013, Chen 2021).

PPD is of particular concern in post-disaster environments, as women are increasingly vulnerable to psychological effects from anxiety and stress (Zotti 2014). Previous studies have found increased levels of depression among postpartum women post-hurricane and other disasters (Xiong 2010, Tees 2010, Zahran 2011). Low-income mothers, single, and those experiencing sudden stressors or significant life events are at higher risk (O'Hare 2013, Beeghly 2003, Mukherjee 2018). A post-Hurricane Katrina study conducted at the Tulane Medical Center on depression in pregnant and postpartum women found that those most susceptible to depression post-disaster were non-partnered women (52% vs. 31%), minority women (40% vs. 22%), and those with low social support (37% vs. 16%). Additional findings indicated that Black women and women with less education endured more adverse hurricane experiences like severe loss, injuries, and illnesses during the disaster (Harville 2010). Another study concluded that

negative hurricane experiences like loss of resources and walking through floodwaters were predictors of PPD at 6 to 12 months post-hurricane (Ehrlich 2010).

A social support system has been shown to enhance postpartum women's ability to combat depression and is a protective factor in post-disaster resilience (Swickert 2009; Vogt 2008). However, disruption to the physical and social environment and the displacement of friends and family often minimizes the social support structure that was in place before the disaster (Norris 2005). Hence, supporting pregnant and postpartum women following a disaster is essential to ensure their mental health and well-being.

1.6 Inequity in Diagnosis of Postpartum Depression

Postpartum depression has been well documented within the literature as a debilitating disorder (Sherman 2018, Fergerson 2002, Bauman 2018), with increased prevalence among single women and those with less than a high school education (O'Hare 2013). Studies have shown that 60% of PPD cases go undiagnosed, and 50% of those diagnosed are left untreated (Ko 2012). Inequity in the diagnosis and treatment of PPD has contributed to some of the challenges women face as they are unable to receive the necessary care.

A study of live births from the Center for Behavioral Health Statistics and Quality, Substance Abuse and Mental Health Services Administration (SAMHSA) found a higher percentage of PPD diagnosis among Medicaid recipients, 13% vs. 7% of those on private insurance. Among individuals with private insurance, 20% received diagnoses the day of birth, compared to 35% of Medicaid recipients. However, after being diagnosed, 36% of private insurance holders sought treatment the same day, compared to 23% of Medicaid recipients, and

after one month of diagnosis, 59% of women holding private insurance received care, compared to 40% of women with Medicaid coverage (Sherman 2018). While the diagnosis of PPD is seemingly higher for Medicaid recipients, those that actively seek treatment and receive the necessary care are disproportionately low.

1.7 Disaster Planning for Pregnant and Postpartum Women

Threat to life, injury, and separation of loved ones contributes to maternal stress in post-disaster environments (Gershon 2004, Callaghan 2007). It has also been shown that adverse post-disaster conditions were associated with nutritional deficiencies in breastfeeding infants and early discontinuation of breastfeeding in general (Summers 2018). Hence, disaster preparedness planning is imperative in helping reduce the damage and disruption pregnant and postpartum women sustain while preparing the environment to maintain their well-being and resilience in returning to pre-disaster conditions (Ewing 2008, WHO 2004, FEMA 2020).

Understanding the barriers to disaster preparedness planning is essential to minimize adverse outcomes following a catastrophic event for those most at risk. Demographic factors and cultural and societal differences play a crucial role in the level of engagement individuals and their community take regarding what to do before, during, and after a disaster (DHHS 2018, Zotti 2014). For example, minority groups lag in preparedness planning, which increases the risk of serious post-disaster outcomes (Donner 2018, Baker 2011). FEMA's US household disaster preparedness assessment found that on average, Hispanic families were less likely than non-Hispanic families to have an emergency preparedness plan in place (32% vs. 44%), respectively

(FEMA 2015). When compared to Whites, Hispanics were less likely to have disaster supplies at home (44% vs. 56%), develop a household plan (32% vs. 44%), enroll to receive community warning alerts (26% vs. 57%), and more likely to indicate that preparedness was not on their radar (45% vs. 59%) (FEMA 2015). In contrast, white, married, educated, and higher-income groups were shown to be more likely to engage in preparedness activities that helped reduce the disaster's impact and increased their ability to return to pre-disaster conditions (Heller 2005, Zilversmit 2014, Martins 2018, FEMA 2020).

The assessment further revealed that 70% of individuals that lived in homes engaged in at least one act of preparedness (FEMA 2015) by indicating to have taken some precautionary measures, 32% had information regarding hazardous plans within their community, 39% had a plan that was shared with family members, 52% set aside supplies in case of a disaster, and 23% indicated to have some form of training to aid during or after a disaster had occurred (FEMA 2015).

Disaster planning often focuses on the individual, but it is also imperative to recognize state and local government's role in engaging the population in preparedness activities. The American College of Emergency Physicians (ACEP) Preparedness Report Card monitors trends affecting emergency medicine and assesses a jurisdiction in four key areas: the ability to reduce current risks, raise awareness, plan for disasters, and implement measures to mitigate future risks. Of the 50 states assessed in the report, two states received an "A" rating, and far more received an "F" (Figure 2.4). The report provided limited information on Puerto Rico disaster preparedness as the report indicated that infrastructure limitations prevented data collection for

the appropriate calculations. Given the experience post-hurricane Maria, it is likely that the level

of disaster preparedness grade, if estimated, would have been within the group of jurisdictions

with an F rating.
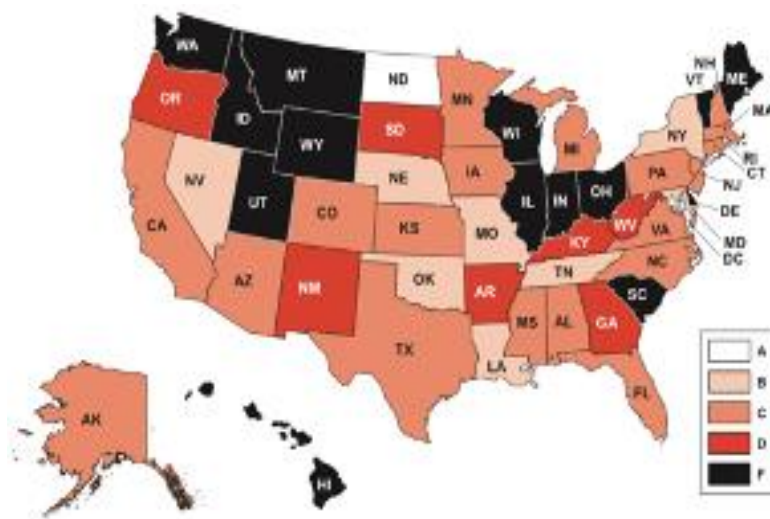
Figure 1.2 Disaster Preparedness State Grades
Source: American College of Emergency Physicians. America's Emergency Care Environment, A State-by-State Report Card 2005– 2014. [New data has not been published]

1.8 State of Maternal Health in Puerto Rico

The Zika outbreak and Hurricanes Irma and Maria disasters exposed the further decay of

an already stretched government and healthcare system in Puerto Rico. Maternal health, for

example, suffered from a decline in obstetricians and gynecologists as physicians with bilingual

skills were heavily recruited for opportunities on mainland United States (Perreira 2017). The Puerto Rican Institute of Statistics estimated an annual emigration of 138 (12%) physicians per year (IEPR 2015).

Despite this shortage, the last 15 years have seen significant improvements in pregnancy and postpartum health. On average, 85% of Puerto Rican women residing in Puerto Rico received first trimester prenatal care compared to 77% of women in mainland-US, and 99% obtain some prenatal care during the gestation period (Osterman 2018, DHHS HRSA 2019). Adverse outcomes such as preterm births (<37 weeks) and low birth weight rates (<2500 g) have been an area of public health concern. In 2008, Puerto Rico was documented as having one of the highest preterm births at nearly 20% vs. 10.4% on the mainland-US (March of Dimes 2011, Bermúdez-Millán 2011). That number decreased significantly to 11% in 2014, and low birth weight went from 12.8% in 2006 to 10% in 2014 (Ferguson 2019, HRSA 2019), but continues to be higher than the overall rate in the United States.

Overall, Puerto Rico experienced improvements in some areas of maternal health. In 2007, maternal mortality was at an all-time high at 25 deaths per 100,000 live births compared to the U.S., at 14 deaths per 100,000. However, in 2014 Puerto Rico experienced a decline to 8.7 per 100,000. Similarly, infant mortality steadily dropped from 9.2% in 2005 to 6.8% in 2014 (WHO 2014, HRSA 2019). Initiatives to increase access to 17-hydroxyprogesterone for pregnant women at risk for preterm birth promoted by the March of Dimes Foundation and to reduce early elective deliveries before 39 weeks of gestation contributed to the decline in preterm births (Ferguson 2019b). The HRSA's Maternal, Infant, and Early Childhood Home Visiting

(MIECHV) grant program, which provided home care for new mothers, also made significant

strides in combating this crisis (ASTHO 2016, HRSA, March of Dimes 2016).
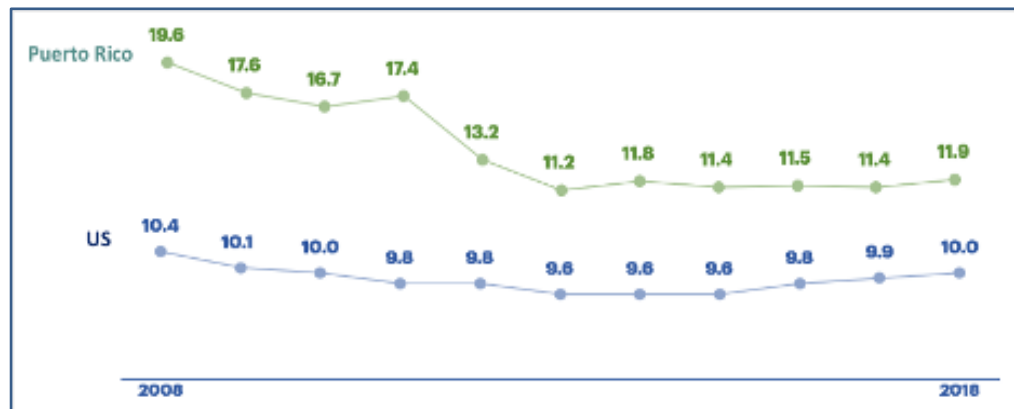
Figure 1.3: Preterm Birth 2008- 2018 U.S. and Puerto Rico
 Source: March of Dimes

1.9 Puerto Rico Economy

Economic challenges following the recession of 2006 led to vast migration to mainland-

US, contributing to a population decline from 3.8 million in 2004 to 3.2 million in 2018. Puerto

Rico has experienced high poverty rates, 43.5% of its citizens live at or below the federal poverty

level compared to 12.7% on the U.S. mainland, and 16% unemployment in 2008 compared to the

U.S. at 5.8% (Roman 2015, Fletcher 2015, Michaud 2017). Already amid a public health crisis

from the Zika virus, the devastation of Hurricane Irma and Maria amplified an already

challenged system that had a $73 billion state deficit leading the Puerto Rico government to

declare bankruptcy after Hurricane Irma and Maria (Durden 2017).

1.10 Gaps in the Literature

Increased disasters from hurricanes to infectious diseases are becoming more commonplace, creating challenging conditions for those in vulnerable communities, including pregnant women and those in postpartum. As studies have shown, under normal conditions, 10% to 16% of women in postpartum experience PPD, and disasters exacerbate these conditions (Ko 2012). While PPD is well documented throughout the literature, studies investigating the impact of disasters on pregnant and postpartum mental health are limited, even less so among the Hispanic population. The most recent study to explore this phenomenon was post-Hurricane Katrina in New Orleans, examining hurricane impact on depression and resilience post-disaster (Harville 2009, Harville 2010, Ehrlick 2010). With the limited availability of research on depression and disasters, underreporting and documenting PPD, there remains a gap in the care of women who continue to suffer from the aftermath of disasters.

1.11 Purpose of Study

This study investigates post-disaster depression related to adverse experiences from Hurricanes Irma and Maria in Puerto Rico, followed by research on disaster preparedness planning with the overarching goal of examining the association of engagement in disaster preparedness planning among postpartum women. Our research focuses on women in Puerto Rico that delivered a live birth post-Hurricane Maria. We assessed depressive symptoms on self-reported feelings of depression and having a lack of interest in activities since their baby was born. The first manuscript examines hurricane experiences and the associated postpartum depressive symptoms among those participating in the study. The second manuscript will assess

the association between engagement in Zika preventive measures and hurricane disaster planning among participants before Hurricanes Irma and Maria.

1.12 Study Aims

This thesis aimed to answer the broad question of "What impact Hurricane Maria had on pregnant and postpartum women in Puerto Rico in the area of stressors, depression, and hurricane preparedness planning." To address this question, we conducted two related studies with the following aims:

1. To examine the role of negative hurricane experiences on self-reported postpartum depressive symptoms and having a lack of interest among postpartum women that delivered a live birth in Puerto Rico.

2. To evaluate if Zika precautionary measures taken during disease outbreaks are associated with the engagement of hurricane disaster planning in pregnant women in Puerto Rico.

CHAPTER 2

METHODS

Data from the Puerto Rico Pregnancy Risk Assessment Monitoring System- Zika Postpartum Emergency Response (PRAMS-ZPER 2.0) was used for this study. The PRAMS-ZPER 2.0 study provides a unique opportunity to examine the extent to which messages developed to reduce the risk of Zika infection among pregnant women may have had additional benefits regarding hurricane experiences and preparedness planning efforts. The PRAMS-ZPER 2.0 also provided a unique opportunity to examine depressive symptoms, capturing crucial data across two significant disasters, the Zika outbreak and Hurricanes Irma and Maria (CDC 2020).

2.1 PRAMS-ZPER

The PRAMS -ZPER 2.0 study was a joint effort between the CDC and the Puerto Rico Department of Health (D'Angelo 2017). The study was designed as a rapid population-based assessment of pregnant women's behaviors and experiences related to Zika virus exposure among recently pregnant women who delivered a live-born infant in Puerto Rico. The primary data obtained from the study was intended to inform emergency response efforts, public health programs, and policies surrounding behaviors towards the prevention of Zika virus in pregnant women and had the following objectives:

1. Describe the knowledge, awareness, and behaviors related to Zika virus exposure among women who delivered a live-born infant through the implementation of a rapid, hospital-based sampling plan.

2. Describe the father's knowledge, awareness, and behaviors related to encouraging Zika virus prevention through the implementation of a hospital-based sampling plan.

3. Educate sampled postpartum women and available fathers on maternal-child health and Zika-related guidelines.

4. Assess parental behavior modification in a two-to-six-month follow-up telephone survey.

5. Provide comprehensive analyses of PRAMS-ZPER data based on an analysis plan designed to update data on programmatic activities and public health practices to prevent Zika virus infection among women of reproductive age in Puerto Rico.

6. Translate and disseminate analytic results into useable information for public health that can guide efforts to prevent Zika virus infection in collaboration with the CDC.

In contrast to the traditional Pregnancy Risk Assessment Monitoring System (PRAMS) surveillance (Shulman 2018), the PRAMS-ZPER 2.0 study sampled women who recently delivered a live-born infant in a hospital during the study period. A PRAMS-ZPER surveyor selected participants from the hospital birth logs and offered the opportunity to complete the survey via tablet or paper survey. This in-person contact had the added benefit for surveyors to promote survey participation. The usual PRAMS surveillance data is based on live birth certificate files, with responses obtained in mailed questionnaire to identified participants with a telephone follow-up.

The PRAMS- ZPER studies were implemented from 2016 to 2018 and comprised of two cohorts, PRAMS-ZPER 1.0 and PRAMS-ZPER 2.0, in participating hospitals that had at least 100 births per year. Only women delivering a live birth during the study timeframe were eligible

17

to participate. Each study cohort had two phases, an in-hospital survey taken during the women's hospital stay 24- 48 hours post birth and a follow-up telephone survey postpartum.

Figure 2.1*: Hurricane Maria and Puerto Rico PRAMS-ZPER study timeline*
Source: Image created from data provided in publication on PRAMS-ZPER study methods and protocol. https://www.cdc.gov/prams/special-projects/zika/docs/pdf/english/PRAMS_ZPER-2.0_Protocol_FINAL_508tagged.pdf (CDC 2020, Salvesen von Essen 2022)

PRAMS-ZPER 1.0 study investigated behaviors, attitudes, as well as precautionary measures taken towards the prevention of Zika and information on mental health. The implementation of the PRAMS-ZPER 1.0, followed by the devastations of Hurricane Irma and Maria, provided a unique opportunity for PRAMS-ZPER 2.0 that in addition to assessing attitudes and behaviors around Zika, it also offered a unique opportunity to capture crucial data on experiences before, during and after the occurrence of Hurricanes Irma and Maria. These were crucial insights in a post-disaster environment related to Zika precautionary measures, hurricane experiences, and disaster planning. As such, data from the PRAMS-ZPER 2.0 was ideal for this dissertation.

2.2 Study Design

This dissertation used data from the PRAMS-ZPER 2.0 survey and broadly examined the association of Hurricane Maria on postpartum mental health among women in Puerto Rico and their engagement in disaster preparedness. This was accomplished by conducting two interrelated secondary data analyses. The first study examined postpartum depressive symptoms post hurricanes Irma and Maria. The second evaluated the association between preventive measures taken to prevent Zika infection and hurricane disaster preparedness planning.

Study Population

The PRAMS- ZPER 2.0 survey participants were selected from women who delivered a live birth in a participating hospital during the study period and agreed to participate in the telephone follow-up. The survey occurred in 2 phases, an in-hospital survey post-delivery during the mother's hospital stay and a telephone follow-up 3-4 months postpartum. Given the post-hurricane hospital situation, potential participants were contacted as soon as possible after birth, often less than 48 hours postpartum (CDC, 2022). Only women completing the in-hospital surveys were eligible for the telephone follow-up survey.

PRAMS-ZPER 2.0 was conducted between November and December 2017, post-Hurricanes Maria and Irma enlisting 30 participating hospitals representing 96% of all live births in Puerto Rico. Damages sustained to the maternal ward of three area hospitals prohibited participation during the study timeframe.

This thesis investigates Hurricane Maria's impact on pregnant and postpartum women in Puerto Rico around stressors, depression, and hurricane preparedness planning. To accomplish this goal, study one, assessed specific questions from the PRAMS-ZPER 2.0 telephone follow-up survey. Study 2, the exposure measure assessed questions related to the engagement of Zika

precaution measures from the PRAMS-ZPER 2.0 in-hospital survey, and the outcome measures evaluated hurricane preparedness from questions in the PRAMS-ZPER 2.0 telephone follow-up survey. Both PRAMS-ZPER 2.0 in-hospital and follow-up survey responses were combined, and only participants that participated in both in-hospital and follow-up surveys responses were analyzed.

The first study asked, "Are negative hurricane experiences during pregnancy associated with reported feelings of depression among postpartum women in Puerto Rico post Hurricanes Irma and Maria?" gauging hurricane stressors and the reported feelings of postpartum depressive symptoms. The second study, "Is the engagement in Zika preventative measures associated with hurricane disaster planning among pregnant women in Puerto Rico? Evaluated Zika infection precautionary measures and the association with the engagement in hurricane preparedness planning.

Study Variables

Specific demographic variables were selected for both studies and analyzed: Mothers' education level, categorized into three areas: Less than high school education and high school graduate or GED, some college and college degree, and graduate degree. Maternal ages were categorized into four groups ≤19, 20-24, 25-34, and 35+, as ages ≤19 and 35+ are associated with more complications during pregnancy, a factor that can impact mental health (Kenny 2013). At the time of delivery, the mother's insurance was categorized into public insurance, including Medicaid, and a public option, private insurance, or no insurance. Participants' municipality of residence was grouped as urban if the municipality population was ≥70,000 and rural if <70,000 (US Census 2020). The "pregnancy intent" variable was dichotomized into intended pregnancy if the mother indicated they wanted to be pregnant then or sooner and unintended pregnancy if the

mother wanted to be pregnant later, did not want to be pregnant, or was unsure of what she wanted. Unintended pregnancies are a public health concern, especially during the Zika outbreak (Adams 2016).

While the PRAMS-ZPER study provided much data on Zika, we did not include variables on Zika infections with the mother or child as infections from Zika among the study population was low; less than 1% of respondents indicated that health care provider had informed them that they had been infected with Zika.

2.3 Hurricane Experiences and Postpartum Mental Health

The first study investigates hurricane experiences on feelings of depressive symptoms and lack of interest in activities postpartum with the following aims and sub aims.

Aim: To examine the role of negative hurricane experiences on self-reported postpartum depressive symptoms and having a lack of interest among postpartum women that delivered a live birth in Puerto Rico.

> *Aim 1a:* Assess the prevalence of self-reported postpartum depressive symptoms and having a lack of interest among postpartum women.

> *Aim 1b*: Evaluate whether patterns of negative hurricane experiences are associated with self-reported feelings of depression and a loss of interest postpartum.

To accomplish these aims, the following research question was assessed: *"Are negative hurricane experiences during pregnancy associated with reported feelings of depression among postpartum women in Puerto Rico post Hurricanes Irma and Maria?"*. We hypothesize that hurricane experiences (i.e., walking through floodwaters, loss of resources, illness/death) are associated with reported feelings of depression.

Exposure Variables

Previous research found an association between exposure to adverse hurricane experiences and depression and PTSD in pregnant and postpartum women (Ehrlick 2010, Harville 2009). For this study, negative hurricane experiences were assessed by participants' response of "Yes or No" to the following questions: "I'm going to read a list of things that could happen because of a hurricane or disaster. For each one, please tell me if you experienced it ***due to the hurricanes***? Would you say that _____? (Yes/No)

    a.   You felt your life was in danger when the disaster struck?

    b.   You were injured or became ill? A member of your household was injured or became ill?

    c.   You walked through debris or floodwater?

    d.   You were without electricity for one week or longer?

    e.   Someone close to you died in the disaster.

    f.   You were living in temporary housing or conditions that you were not accustomed to?

    g.   You lost personal belongings?

    h.   You were separated from loved ones who you feel close to?

    i.   You had trouble getting services or aid from the government?

    j.   You had trouble dealing with insurance or disaster relief agencies?

    k.   You had trouble getting clean drinking water?

    l.   You had trouble getting enough food to eat?

    m.   You felt unsafe because of the lack of order and security after the disaster?

    n.   You had to move to another municipality?

The questions were categorized into four areas: Perceived Life-Threatening events, Loss of Resources, Disruption in Housing, and Trouble obtaining Governmental Aid (Lai 2014). Perceived Life-Threatening events included the following six questions: Felt unsafe due to lack of order, felt life was in danger, injured or became ill, a household member was injured or became ill, someone close to you died in the disaster, and you walked through debris or floodwater. Questions were summed (ranging from 0 to 6) and categorized into three areas: "0" representing no Perceived life-threatening events, "1 to 2" representing some perceived threats, and "3 to 6" those individuals that experienced multiple perceived life-threatening events.

The Loss of Resources variable included three questions: loss of electricity, food, and access to clean water. When summed, the range was "0 to 3", with "0" indicating no loss. The number of respondents indicating "no loss" was less than 1% [n=8 (0.64%)] and was therefore combined with 1 to represent "little or no loss," while 2 and 3 were grouped to represent multiple loss of resources. Disruption in housing variable comprised of the following four questions: lived in temporary housing, had to move to another municipality, personal items were lost, and got separated from loved ones. Likewise, questions were summed and categorized, ranging from 0 to 4, with 0 representing no housing disruption and 1 to 2 collapsed to represent respondents experiencing some level of disruption with housing post-hurricane and 3 to 4 multiple disruptions.

Finally, trouble obtaining governmental aid includes trouble receiving aid and difficulty dealing with insurance. This group was summed and categorized as "0" had no problem receiving aid, and "1" or more, had trouble receiving assistance.

Outcome Variables

We measured the primary outcome of interest, depressive symptoms, and lack of interest postpartum from the PRAMS-ZPER 2.0 telephone follow-up survey. Depressive symptoms refer to the reported feelings as indicated by study participants at the time of this assessment and is not a clinical assessment of depression. As such, the following two questions were asked:

> 1. Since your new baby was born, how often have you felt down, *depressed*, or hopeless? Would you say it's been always, often, sometimes, rarely, or never?

> 2. Since your new baby was born, how often have you had little interest or little pleasure in doing things you usually enjoyed? Would you say that it's been always, often, sometimes, rarely, or never?

Responses "Always and often" were collapsed to indicate having the condition (depressive symptoms, lack of interest), while "rarely and never" were classified as not having the condition (no depressive symptoms, having an interest in things you enjoy).

Statistical Analysis Study One

To examine the association between the exposure and outcome of interest, bivariate analyses were conducted between the primary exposures: Hurricane experiences (Perceived life-threatening events, Loss of Resources, Housing Disruption, and Trouble receiving Governmental Aid), and outcome of interest: Postpartum depressive symptoms and Lack of Interest Postpartum.

Multiple regression analysis was then conducted to evaluate the influence of hurricane exposure on both outcomes, Postpartum Depressive Symptoms and Lack of Interest Postpartum. A multinomial logistic regression model was used to examine these associations and obtain the unadjusted Prevalence Odds Ratio (POR), the adjusted aPOR, and the 95% confidence interval. Each multivariable analysis controlled for socio-demographic factors. A statistical analytical

weight was applied to each model based on an adjustment factor accounting for declining birth rates to estimate the number of 2017 births in each region. For information on the development of the adjustment factor, the full report on the PRAMS-ZPER 2.0 sampling protocol can be found at https://omb.report/icr/201708-0920-008/doc/76047901. Table details are outlined in chapter 3 results. To address missingness, a complete case analysis approach was utilized to which represented less than 10% of our sample.

2.4 Hurricane Disaster Planning and Zika Virus

Disaster planning is essential to minimize the potential damages incurred post-disaster, allowing for a speedy recovery and return to pre-disaster conditions. The increased challenges from multiple disasters are apparent today; as such, study 2 examines hurricane disaster preparedness planning during the Zika virus outbreak. This is a cross-sectional analysis with the data collected in a prospective manner, as the outcome data were collected at a second point. For this analysis we ask the following research question.

Research Question: Is the engagement in Zika preventative measures associated with hurricane disaster planning among pregnant women in Puerto Rico?

Aim 2: To evaluate if Zika precautionary measures taken during disease outbreaks are associated with the engagement of hurricane disaster planning in pregnant women in Puerto Rico.

Aim 2a: To assess the prevalence of the engagement in Zika precautionary measures and disaster planning efforts reported by postpartum women during pregnancy.

Aim 2b: Evaluate if the engagement in Zika precautionary measures is associated with hurricane disaster planning.

We hypothesize that the engagement in Zika preventative measures is associated with pregnant women conducting hurricane disaster preparedness planning prior to Hurricane Maria in Puerto Rico.

Data Collection

Data for PRAMS-ZPER 2.0 were collected from November to April 2018, with the in-hospital interviews occurring November to December 2017 and the telephone follow-up, February to April 2018. Some adjustments included reducing the sample size and eliminating the 24- to 36-hour waiting period before contact were made from the previous PRAMS-ZPER 1.0 study.
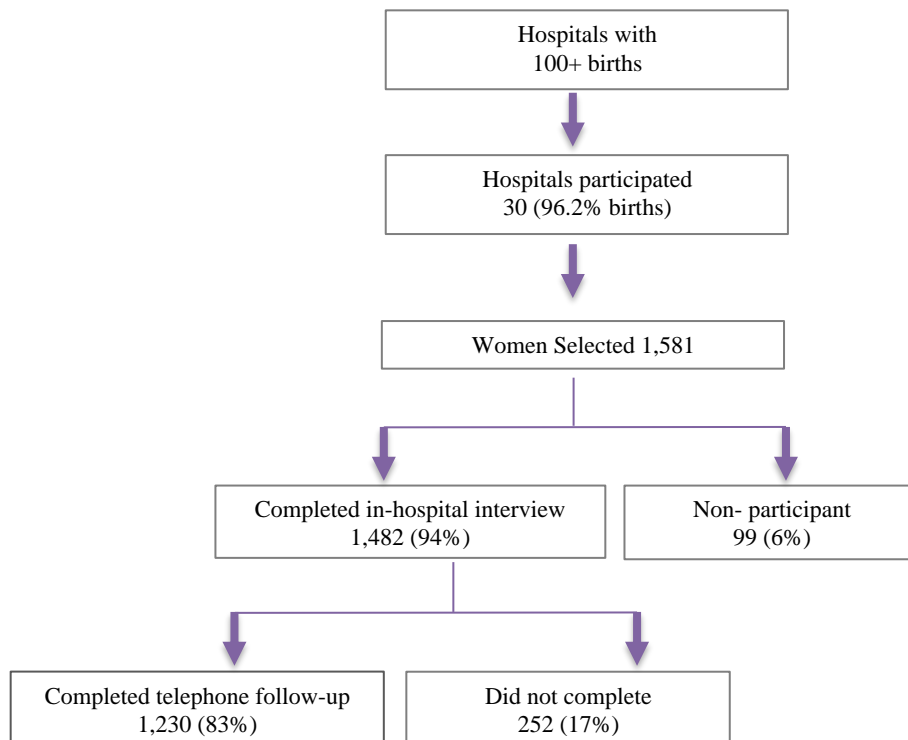
Figure 2.2*: PRAMS-ZPER 2.0 Study sample Puerto Rico 2017 -2018*
*Source: Image created from data provided in publication (*Salvesen von Essen, 2022)

Among the 1,581 women selected for the in-hospital survey, 1,482 completed for an overall response rate of 94% and 1,230 completed the telephone follow-up 2-3 months post-delivery for an 83% response rate.

The sample design for this study is cross-sectional, with the data collection for Zika precautions collected retrospectively (after the fact). While data collected on hurricane experiences were collected retrospectively, it was collected approximately three months after the in-hospital interviews.
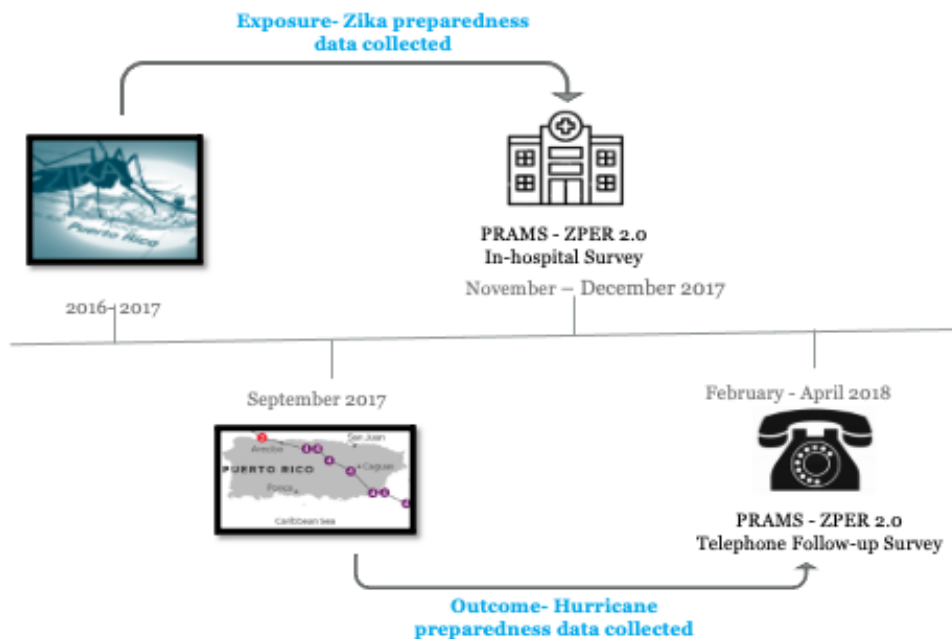
Figure 2.3*: PRAMS-ZPER 2.0 Data collection timeline Puerto Rico 2017 -2018
*Source: Image created from data provided in protocol (*CDC, 20)

Exposure variables:

For this analysis exposure variables were study participants' responses to three groups of behavior questions related to mosquito bite precaution reported during the PRAMS-ZPER 2.0 in-hospital survey. The specific question were framed to the most recent pregnancy and the questions were:

1. *Did you do any of the following things to avoid mosquito bites in your home?* Response options included: (a) Always used screens on open doors?, (b) Always used screens on open windows?, (c) Always kept unscreened doors and windows closed?, (d) Slept under a mosquito bed net?, (e) Set up mosquito traps?, and (f) eliminated standing water from my house and yard on a weekly basis?

2. *Did you receive any of the following professional services for mosquitoes?*

   Response options included: (a) Indoor spraying of my house for mosquitos?, (b) Outdoor spraying around my house and in my yard for mosquitoes? and (c) Application of larvicides around the outside of my house?

3. *How often did you use a mosquito repellent on your exposed skin or clothing when you went outside, even if you were only outside for a short time??* This was a single response question with the following options: (a) Always, (b) sometimes, (c) rarely, or (d) never.

Questions were summed by their respective groups to create the following composite variables: Mosquito Bite Prevention, Professional Mosquito Services, and Repellent usage. Mosquito bite prevention comprised of six items that were summed and scored, ranging from "0" (no engagement) to "6" (high engagement). Because only 18 (1.7%) respondents reported no to

activities in any categories of this group, this group was merged with those engaged in 1 area of

participation and labelled as "little or no engagement." A score of "2 to 3" was labelled moderate

engagement, and a score of "4" or more, was labelled high engagement.

Professional Mosquito services index contained three items combined to create a binary

response of zero "0" not using professional mosquito services and "1" receiving one or more

professional mosquito services. Those indicating that they always or sometimes used repellent

when going outside responses were collapsed to represent engagement in use of repellent, and

rarely and never were collapsed to represent a lack of engagement in repellent use.

Outcome Variables:

The primary outcome of interest is the engagement in disaster planning, assessed by

analyzing the results of the following eight questions from the PRAMS-ZPER 2.0 telephone

follow-up survey:

1. You had an emergency meeting place for family members other than your home?
2. Your family and you had practiced what to do in case of a disaster?
3. You had a plan for how your family and would keep in touch if separated?
4. You had an evacuation plan if you needed to leave your home or community?
5. You had an evacuation plan for your child or children in case of a disaster for example permission for day care or school to release your child to another adult?
6. You had copies of important documents like birth certificates and insurance policies in a safe place outside your home?
7. You had emergency supplies in your home for your families, such as enough extra water, food, and medicine to last for at least three days?

8. You had emergency supplies prepared that you kept in your car, at work, or at home to take with you if you needed to leave quickly?

The disaster preparedness activity questions were grouped and summed to generate a composite score creating the "Disaster Household Preparedness Index". The categories represent three areas of disaster preparedness planning: Family Disaster Planning, Evacuation Planning, and Family Supplies (Zamboni 2020, Thomas 2015). Family disaster planning consists of four questions: having a family meeting place, family engagement in practice drills in case of disaster, family plan to keep in touch, and having documents. Evacuation planning had two questions: an evacuation plan and a child evacuation plan. The remaining two questions, having emergency supplies at home and having emergency supplies away from home, formed the Family Supplies group.

These subgroups were summed and dichotomized to create a binary outcome of "0" not engaging in any activities within the respected categories and "1", engagement in at least one of the preparedness categories (Al-Rousan 2015). The results were summed to create a composite score ranging from 0 to 3. Zero "0" represented no engagement in any hurricane disaster planning, and "3" engaged in all three areas. The number of participants engaging in no planning "0" was 17 (1.4%), so this group was combined with engagement in one "1" planning area to represent Limited Planning, "2" represented engagement in 2 planning areas -Moderate Planning), and "3" engagement in all three planning areas -Adequate Planning.

Study 2: Statistical Analysis

Univariate analyses were conducted for descriptive analysis, and bivariate and multivariate analysis was then performed using multinomial logistic regression models to

investigate the relationship between the exposure variable Zika precautionary measures: mosquito bite prevention, professional mosquito services, and repellent usage, and the outcome of interest, hurricane preparedness planning to obtain the unadjusted and adjusted Prevalence Odds Ratio (aPOR) and the 95% confidence interval. Multivariate model controlling for socio-demographic factors and a statistical analytical weight applied based on an adjustment factor that accounted for declining birth rates was used to estimate the number of 2017 births in each region. Missing data for this study was minimal, so a complete case analysis approach was used to handle missingness, representing less than 10% of our sample. For information on the development of the adjustments made, the full report on the ZPER 2.0 sampling protocol can be found at https://omb.report/icr/201708-0920-008/doc/76047901. Table details are outlined in the results section of chapter 4.

2.5 Theoretical Framework

This study's theoretical underpinning is based on the Psychosocial Epidemiology Framework: A Social Epidemiological approach to social experiences and resulting health circumstances that lead to disease onset within the population (Krieger 2001). The framework incorporates three core concepts: Adverse psychological stressors, in this case, (1) the experiences endured as a result of hurricanes, like experiencing an injury, death of a loved one, walking through floodwaters, loss of resources, etc., (2) Individuals' social rank - psychological stress from being pregnant or for women in postpartum, enduring the stress from childbirth coupled with living in a post-disaster environment., and (3). Adverse psychological stress – as a result of living through the hurricane and disruption in the environment, social support structures, and housing, among other challenges- places an undue burden on coping with the day-to-day responsibilities resulting in psychological distress.

Essentially, this framework focuses on the mental/psychological interpretation of a social phenomenon (stressors). As such, the manifestation and extent of disease onset is a direct interpretation of an individual's relationship to the environment and their susceptibility to stressors (Sapolsky 2004, Marmot 2004). Likewise, social support systems within the population potentially buffer and or hamper disease onset in the face of a great deal of stress, physical, social, or environmental (Abdiani 2019).

CHAPTER 3

MANUSCRIPT ONE: THE ASSOCIATION OF NEGATIVE HURRICANE EXPERIENCES

ON SELF-REPORTED FEELINGS OF DEPRESSION AND LOSS OF INTEREST AMONG

POSTPARTUM WOMEN IN PUERTO RICO.[1]

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[1] Livingstone, S. H., et al. To be submitted to the *Journal of Disaster Management*

3.1 Abstract

Background: Hurricane frequency and intensity have increased in the last decade, resulting in ever-growing disasters. Pregnant and postpartum women are susceptible to adverse outcomes during and post disasters, including mental health disorders. Studies have shown an increase in depression among pregnant and postpartum women post-disaster; however, they are limited in the number and diversity of populations studied. We assessed the association between hurricane experiences and postpartum depressive symptoms and a lack of interest in activities postpartum among women that delivered a live birth in Puerto Rico following Hurricanes Irma and Maria.

Methods: PRAMS-ZPER 2.0 telephone follow-up survey was used to assess the exposure of hurricane experiences by grouping15 hurricane experience questions into four categories (perceived life-threatening events, loss of resource, housing disruption, and trouble receiving government aid). The categories were summed to create a composite score. The outcome variables were postpartum depressive symptoms and lack of interest postpartum and assessed as having symptoms always, sometimes, or never. Univariate analysis bivariate and multivariate analysis using multinomial logistic regression models were conducted to measure how the exposure was associated with the outcome of interest.

Results: Overall, 1,230 study participants completed the in-hospital and telephone follow-up surveys. A total of 20% reported depressive symptoms, with 4% reported always experiencing postpartum depressive symptoms, and 16% indicating sometimes. Hurricane experiences were associated with postpartum depressive symptoms. Specifically, women experiencing one to two life-threatening events had an increased likelihood of depressive symptoms [aPOR 1.68 (1.08, 2.61)] and those experiencing three or more life-threatening events

also had a higher likelihood of depressive symptoms [aPOR 1.83(1.07, 3.11)] when compared to those experiencing no events. Among those experiencing a loss of resources, also had an increased likelihood of postpartum depressive symptoms [aPOR 1.62 (1.17, 2.24)].

Conclusion: These findings suggest that hurricane experiences are associated with a higher likelihood of depressive symptoms. Hence, pregnant, and postpartum women experiencing negative hurricane experiences should be offered mental health services to address potential depressive symptoms and to ensure their ability to receive the necessary needed help to facilitate resilience and the ability to return to pre-disaster conditions.

3.2 Introduction

In September 2017, mega-storm Hurricane Maria made its way through the Caribbean as a Category Five storm devastating Dominica, the Virgin Islands, and the island of Puerto Rico. Hurricane Maria made landfall in Puerto Rico with sustaining winds of 155 mph as a Category Four storm, creating catastrophic flooding that amplified Hurricane Irma's impact that hit Puerto Rico just two weeks prior (NWS 2019).   Hurricane Maria was one of the worst and deadliest storms in the Atlantic since Hurricane Georges in 1998 (Sattler 2002, Reuben 2013). The devastation to crucial infrastructure left many without access to basic food, supplies, clean water, medical services, and electricity for weeks while enduring waist-deep sewage-ridden flood waters creating damages estimated at $90 billion (Meyer 2018, NWS 2018, Rudner 2018).

In recent years, there has been an increase in natural disasters. The United Nations reported climate crisis had increased six-fold in the last five decades (Hart 2021). The World Health Organization (WHO) noted that more resources are currently being spent on disaster relief efforts than before, often at the expense of development. At the same time, improvement in development is needed to minimize the vulnerability of those areas to ward off the devastations of disasters (WHO 2002).

The impact of hurricanes often places an undue burden on society, disproportionately impacting those that are economically burdened, socially isolated, disabled, as well as pregnant and postpartum women (Callaghan 2007, Buttnell 2009, Runkle 2012). More than often, pre-and postnatal women's needs are overlooked in a disaster situation, leaving them exposed and at an increased risk for less than desirable health outcomes (O'Brien, 1998; Hung, 2018; Lauve, 2017).

3.3 Post-Disaster Psychological Health

Previous studies found exposure to adverse hurricane experiences linked to depression, post-traumatic stress disorder (PTSD), mental health disorders, and maternal distress in pregnant and postpartum women (Ehrlick 2010, Harville 2009, Ashman et al., 2008, Cummings et al., 2005). A study at Tulane Medical Center on depression and PTSD in pregnant and postpartum women following Hurricane Katrina found that non-partnered women, those with low social support, and minority women were more susceptible to depression and PTSD post-disaster. Those impacted by Hurricane Katrina showed less partner support and were more likely to report that they felt less prepared for the hurricane (Harville 2010).

Postpartum women with a social support system were shown to have the ability to combat depression, increase resilience, and posttraumatic growth post-hurricane (Swickert 2009, Vogt et al., 2008). Women found to be resilient were more likely to be white and partnered, while in contrast, minority women, and those who were less educated, showed less resilience and had a greater risk of enduring more adverse hurricane experiences like injury, loss, and or damages to their home (Ehrlick 2010, Harville 2009).

Consistent with other findings, disasters have been associated with an enhanced need for mental health services leading to an increased risk of posttraumatic stress, anxiety, and depression (Bevilacqua 2019, Ferguson 2014). Post-Hurricane Maria, the Puerto Rico government-ran suicide hotline, reported over 3,000 crisis calls between November 2017 and January 2018, three times the amount received during the same period the previous year (Milligan 2018).

Post-Hurricane Katrina studies found that hurricane experiences are a predictor of Postpartum Depression (PPD); those that experienced the loss of resources and walking through

floodwaters, among other hurricane experiences, were associated with a higher likelihood of PPD 6 to 12 months post-disaster (Ehrlich 2010). PPD has been well documented as a debilitating disorder affecting 10-15% of women up to a year after birth (Sherman 2018, Fergerson 2002, Bauman 2018). PPD is presented by extreme levels of sadness and anxiety that impact a woman's ability to care for herself and others and is prevalent among single women and those with less than a high school education (CDC 2008, Sherman 2018, O'Hare 2013, Ko 2017). It is reported that 60% of PPD cases go undiagnosed, and 50% of those diagnosed are left untreated (Ko 2012). Such conditions can be amplified in a post-disaster environment and have suggested that women from non-English speaking countries are at an increased risk of not receiving the necessary medical care during such a crisis (Liu 2014).

As natural disasters and emerging infections increased in recent years, Puerto Rico experienced back-to-back disasters from the Zika outbreak, Hurricanes Irma, and Maria. Such disasters can leave pregnant and postpartum women vulnerable to pregnancy-related adverse outcomes, including PPD. While PPD has been well studied, very little is known about PPD during and post-disaster environments

This study investigates the impact of adverse hurricane experiences among Puerto Rican women post-Hurricanes Irma and Maria on self-reported postpartum depressive symptoms and experiencing a lack of interest in postpartum activities. A lack of interest or pleasure in hobbies and activities is one of the more common symptoms of PPD but has been less documented in studies (NIMH 2010).

3.4 Methods

This is a cross-sectional analysis that utilized data from the CDC Pregnancy Risk Assessment Monitoring System -Zika Postpartum Emergency Response 2.0 (PRAMS-ZPER)

study, a collaboration between the Centers for Disease Control and Prevention (CDC) and the Puerto Rico Department of Health. The PRAMS-ZPER study was a rapid, population-based assessment of maternal behaviors and experiences related to Zika virus exposure among recently pregnant women in Puerto Rico who delivered a live birth following Hurricane Maria hitting Puerto Rico. The sampling was based on previous estimates using the CDC's PRAMS approach (CDC 2020c).

Study participants were selected from hospitals with at least 100 births per year. Thirty-four (34) hospitals were eligible, representing 99% of all live births on the island. The PRAMS-ZPER 2.0 had two components: an in-hospital data collection that occurred post-delivery during the mother's hospital stay, followed by a telephone follow-up survey 3-4 months post-delivery. Only women completing the in-hospital surveys were eligible for the telephone follow-up survey. PRAMS-ZPER 2.0 was conducted in Fall 2017 post-hurricane Maria and the telephone follow-up in Spring 2018.

For this study, we utilized the data collected in PRAMS-ZPER 2.0 telephone follow-up survey. Thirty hospitals participated in this study representing 96.2% of all live births in Puerto Rico. Four hospitals did not participate in the survey, three due to damages sustained from the hurricane, and their maternal wards were closed during the sampling period and one hospital did not agree to participate (CDC 2020)

Study participants were selected from women admitted to a participating hospital during the study period from November to December 2017 and who delivered a live-born infant. The telephone follow-up survey was limited to those women who participated in the in-hospital study and were matched with birth certificate information for the telephone follow-up. A letter was mailed to the participants informing them of the upcoming telephone survey. For more detailed

information regarding the PRAMS-ZPER protocol, please visit the CDC PRAMS website

[PRAMS Zika Postpartum Emergency Response Survey (PRAMS-ZPER) in Puerto Rico](#). (CDC 2020)

Variables and Measurements

Exposure Variable: Hurricane Experience:

Study participants were asked to respond "Yes or No" if they experienced any of 15 events during and after the hurricane. These questions were categorized, summed, and scored into four areas: perceived life-threatening events, loss of resources, housing disruption, and trouble obtaining governmental aid (Lai 2014) (*See* Appendix 1). Perceived life-threatening events included six questions: felt unsafe due to lack of order, felt her life was in danger, were injured or became ill, a household member was injured or sick, someone close to you died in the disaster, and you walked through debris or floodwater. Questions were summed (range from 0 to 6) and grouped into three categories: "0" representing no perceived life-threatening events, "1 to 2" representing some perceived threats, and "3 to 6" for individuals that experienced multiple perceived life-threatening events.

Loss of resources included three questions: loss of electricity, lack of food, or access to clean water. Since the number reporting no loss was less than 1%, we combined that group with those experiencing loss in 1 area into a category of "little or no loss," while reporting two or three losses were assigned to the category of multiple loss of resources. Disruption in housing included living in temporary housing, moving to another municipality, losing personal belongings, and getting separated from loved ones. Likewise, questions were summed and categorized, ranging from 0 to 4, with 0 representing no housing disruption, 1 to 2 some housing

disruption, and 3 to 4 multiple disruptions in housing post-hurricane. Finally, obtaining governmental aid included trouble receiving assistance and difficulty dealing with insurance. This group was summed and categorized as "0" had no problem receiving aid, and "1" or more, had trouble receiving assistance.

*Outcome Variables***:** Postpartum Depressive Symptoms and Lack of Interest

To examine postpartum depressive symptoms, we analyzed the question: "Since your new baby was born, how often have you felt down, depressed, or hopeless?". Respondents' choices were always, often, sometimes, rarely, or never. Responses of "always and often" were classified as having depressive symptoms, and "rarely or never" were grouped as not having depressive symptoms. To examine lack of interest, we analyzed the question: "Since your new baby was born, how often have you had little interest or little pleasure in doing things you usually enjoyed?" Similarly, to the previous question, responses of "always and often" were classified as having a lack of interest and reactions of rarely or never were grouped as not having a lack of interest.

Covariates:

Socio-demographic characteristics included mothers' education level, categorized as having (1) less than high school education, high school graduate or having a GED, (2) some college or college degree, and (3) graduate degree. Age was grouped as ≤19, 20-24, 25-34, and 35+. Mother's insurance was categorized as public insurance, representing those that have Medicaid to include a public option and private insurance holders at the time of delivery. Participants' municipality of residence was classified as urban if the population was ≥70,000 and rural if <70,000 based on the 2020 US Census. The "pregnancy intent" variable was

dichotomized into intended pregnancy if participants indicated they wanted to be pregnant then or sooner, and unintended pregnancy, if they wanted to be pregnant later, did not want to be pregnant, or were unsure of what they wanted. Social support was assessed by a "Yes or No" response to the following three questions: Since the hurricanes, would you have: (1) someone to loan you $50, (2) someone to help you if you were sick and needed to be in bed, and (3) someone to talk with about your problems. The yes responses were scored as one and no as zero and summed with scores ranging from 0 to 3, with 0-2 combined into a category of incomplete support and support in 3 areas as complete support.

3.5 Statistical Analysis

Univariate analysis was conducted for descriptive analysis, and Pearson correlation coefficients were calculated to check the linear correlations among independent and outcome variables and demographic factors (figure 3.3). Bivariate and multivariate analyses using multinomial logistic regression models were carried out to evaluate the influence of hurricane exposure on the outcome of postpartum depressive symptoms and lack of interest. First, we evaluated trends among participants reporting no depressive symptoms and those reporting depressive symptoms postpartum, which include those reporting depression always and sometimes. Similarly, interest in activities and lack of interest postpartum were examined. We then conducted multivariate analysis using a multinomial logistic regression to assess age and education for trends within each category modeled for both primary outcomes - postpartum depressive symptoms and lack of interest postpartum obtaining the unadjusted Prevalence Odds Ratio (POR) and adjusted Prevalence Odds Ratio (aPOR), and the 95% confidence interval.

Each multivariable analysis controlled for socio-demographic factors as stated above. A statistical analytical weight based on an adjustment factor that accounted for declining birth rates to estimate the number of 2017 births in each region was applied to each model. For information on the development of the adjustments factor, the full report of the PRAMS-ZPER 2.0 sampling protocol can be found at https://omb.report/icr/201708-0920-008/doc/76047901. All statistical analyses were carried out using STATA 16.1.

3.6 Results

Overall, 1,545 women were selected to participate in the PRAMS-ZPER 2.0 study, with 1,482 completing the in-hospital surveys and 1,230 completing the telephone follow-up interviews 3 to 4 months postpartum in the Spring of 2018. This resulted in 83% of participants completing both hospital and telephone follow-up surveys. Table 3.1 describes the study participants by sociodemographic characteristics. In summary, participants were more likely to experience 1 to 2 life-threatening hurricane events (55%), with close to half, 49% experiencing 2 or more loss of resources, and more than half, 51% experiencing housing disruptions in 1 to 2 areas. Participants were also more likely to have a post-college education (42%), be unmarried (68%), have Medicaid or Public option insurance (69%), and reside in a rural municipality (61%).

Overall, 20% of study participants reported experiencing depressive symptoms, with 4% of women reporting experiencing depressive symptoms "always" and 16% experiencing depressive symptoms "sometimes." A total of 26% of participants reported experiencing some level of lack of interest postpartum, with 8% indicating experiencing these symptoms "always" and 18% indicating experiencing these symptoms "sometimes."

43

This study found that the number of hurricane experiences were associated with postpartum depressive symptoms (Table 3.3). Specifically, among those experiencing 1 to 2 life-threatening events had a 68% likelihood of experiencing depressive symptoms than those experiencing no life-threatening events [aPOR 1.68 (1.08, 2.61). Among those experiencing three or more life-threatening events, had an 83% likelihood of experiencing depressive symptoms when compared to those experiencing no life-threatening events [aPOR 1.83(1.07, 3.11)]. People experiencing multiple losses of resources during the hurricane had a 62% increased likelihood of postpartum depressive symptoms when compared to those experiencing little or no loss [aPOR 1.62 (1.17, 2.224)].

Hurricane events that were perceived as life-threatening showed some evidence to support the association of having a lack of interest in activities postpartum (Table 3.4). With those experiencing 1 to 2 life-threatening events had an increased likelihood of experiencing a lack of interest postpartum [aPOR 1.94 (1.32, 2.88)]. Those who report experiencing three or more life-threatening events had twice the odds of developing a lack of interest in activities postpartum compared to those experiencing no life-threatening events [aPOR 2.21(1.36,3.62)]. No significant associations were detected between those reporting multiple loss of resources, housing disruption, or challenges receiving government aid and having a lack of interest in activities postpartum.

Multivariate regression models showed significant associations between hurricane experiences and depressive symptoms "sometimes" but not "always" (Table 3.5). Specifically, among those experiencing 1 to 2 life-threatening events, there was 74% greater odds of depressive symptoms when compared to those experiencing no life-threatening events [aPOR 1.74 (1.07, 2.82)]. For those experiencing multiple losses of resources, a 56% increased

likelihood of depressive symptoms was evident among those experiencing little to no loss of resources [aPOR 1.56 (1.1, 2.22)]. Study participants who indicated experiencing housing disruptions in 1 to 2 areas were 58% more likely to indicate experiencing depressive symptoms sometimes when compared to those experiencing no housing disruptions [aPOR 1.58(1.04, 2.39)].

Women whose pregnancies were categorized as unintended had an 82% increased likelihood of reporting depressive symptoms "sometimes" when compared to women whose pregnancies were categorized as intended [aPOR 1.82(1.26, 2.62)]. Findings from our study provide some evidence that having a social support system is associated with protecting against depressive symptoms. Among participants that were grouped as having incomplete support system (support in less than 3 areas) were more than twice as likely to report experiencing depressive symptoms when compared to those with a complete support system (having support in all 3 areas) [aPOR 2.32 (1.08, 5.00)].

When examining the association between hurricane experiences and having a lack of interest, we found that women experiencing three or more life-threatening events had a 2.5 times greater odds of reporting to always experience a lack of interest postpartum when compared to those experiencing no life-threatening events [aPOR 2.52 (1.11, 5.72)], and among those experiencing 2 or more loss of resources had a 63% greater likelihood of experiencing having a lack of interest when compared to those experiencing 0 to 1 loss [aPOR 1.63 (1.01, 2.65)]. In addition, living in rural communities was associated with a reduced likelihood of having a lack of interest when compared to those living in urban communities [aPOR 0.58 (0.37, 0.92)].

Study participants who experienced 1 to 2 life-threatening hurricane events had 98% increased odds of having a lack of interest in activities [aPOR 1.98, (1.28, 3.11)], and for those

experiencing three or more life-threatening events, 91% increased odds of lack of interest when compared to those experiencing no life-threatening events [aPOR 1.91, (1.10, 3.35)]. Unintended pregnancies were associated with having a lack of interest postpartum, with 78% increased odds among women who identified their pregnancies as unintended compared to pregnancies categorized as intended [aPOR 1.78(1.27, 2.50)].

3.7 Discussion

Overall findings from this study indicate that postpartum women with a live birth experiencing hurricane disasters during pregnancy are at risk for mental health concerns. Specifically, this analysis suggests hurricane experiences to be associated with depressive symptoms and having a lack of interest postpartum. When looking at depressive symptoms compared to no depressive symptoms postpartum, there were clear associations among those experiencing events categorized as life-threatening and loss of resources but not for those experiencing housing disruptions as defined as having to move to another municipality, living in temporary housing, or getting separated from loved ones because of the hurricane. Similarly, association with hurricane experiences and having a lack of interest in activities postpartum was observed among those experiencing life-threatening events and multiple loss of resources (Ehrlick 2010, Flores 2020).

Housing disruptions were not significantly associated with experiencing depressive symptoms within our population in the adjusted model. This is suspected to be a result of a small number of observations in the "always" depressed category. A secondary analysis to investigate if an increase in the number of housing disruptions was significant among those experiencing no housing disruption compared to those experiencing one or more housing disruptions. This model

was shown to be significant among those experiencing overall depressive symptoms [POR 1.33 (1.11, 1.59)] but not in the adjusted model [aPOR 1.19 (0.97, 1.48)] controlling for all variables. The increased number of housing disruptions was not associated with depressive symptoms.

Other studies have also found an association between hurricane experiences and depression. In a post-Hurricane Katrina study of depression in postpartum women found that those experiencing two or more severe hurricane experiences was associated with depression [RR 1.77 (1.08, 2.89)] (Harville 2009b).

In all the models in our study, the mother's age, education, or marital status were not found to be significant for postpartum depressive symptoms as other research had previously indicated (O'Hare 2013, Ko 2017). We speculate that depression may be underrepresented in our study population potentially due to the continued stigma surrounding depression might lead to a reluctance among postpartum women to admit their experiences but instead provide a socially acceptable response (Backstrom 2009). As other studies have shown (Callister 2011, Chaudron 2005), postpartum depression is pervasive among Hispanic women but not readily reported and under-detected by their healthcare providers. Some studies have shown as high as 37% of Hispanic women are affected by PPD compared to 10-15% in the US population (Stapler 2017). Cultural expectations of motherhood and mental health perceptions might account for the varying rates reported across racial and ethnic minority groups (Howell 2005).

In our study, participants were more likely to indicate a lack of interest postpartum (8% n=98), a predictor of depression, while only 4% (n=46) reported experiencing depressive symptoms. Such findings could suggest that other predictors of depression potentially could yield a higher representation of the actual burden of disease within the population, like feelings of "guilt, sadness, inadequacy, tearfulness, listlessness, sleep disturbances, inability to

concentrate, and mood lability," (Martinez-Schallmoser 2003, Sun 2021). Sleep disturbances have been observed in 70% of adults with post-traumatic experiences (Bryant 2010). Cultural norms and existing beliefs are also to be considered, as a study of Caribbean women indicated that the fear of being viewed as "weak" and not being able to handle the daily dealings of motherhood was the underlying cause of reluctance to admit to having feelings of depression (Tyson 2016).

Unintended pregnancy is a public health concern, with Puerto Rico reporting one of the highest among the US States and Territories at 65% (Lancaster 2010, DHHS 2019). Among our study participants, 56% of pregnancies were categorized as unintended, similar to the 2017 Puerto Rico Pregnancy Risk Assessment Monitoring System (PRAMS) findings (CDC 2020a). This decline is potentially attributed to the ongoing efforts from the Puerto Rico Department of Health and the CDC in their campaign to reduce unplanned and untimed pregnancies during the Zika outbreak by providing free contraceptives (CDC 2020).

Studies have indicated that social support is protective against postpartum depressive symptoms (Collins 2021, Mitchell, Wadsworth 2009). However, housing disruption and displacement during a disaster can negatively impact support networks (Norris 2005). Over 82% of our study participants reported strong social support, and the findings suggest being protective among those experiencing depressive symptoms (Gress 2012). A study of rural Appalachian women in Ohio revealed that women with low levels of support had a higher prevalence of postpartum depression (Collins 2021). Such findings further support the need for research among residents within their homeland to understand the impact of family and friends on coping post-disaster (Norris 2005).

The uniqueness of this study is that it provides an opportunity to investigate postpartum mental health immediately post-disaster in Puerto Rico. Research on the experiences of Hispanics and Latin women vulnerable to disasters often on mainland US, and limited studies on US Territories (Cutter 1996, Elliott 2006). Such lack of research limits understanding of the burden of disease and does not necessarily reflect the experience outside of mainland United States (Flores 2020, Ehrlich 2010).

Some limitations of this study to mention, first the results are limited to women who delivered a live birth in Puerto Rico, so there is limited knowledge of the effects of women that suffered fetal loss post-hurricane. Depressive symptoms and lack of interest are self-reported indicators within our study and not clinical assessments; hence, we cannot be sure that these experiences were limited to the hurricane or assessed the mental state of the individuals during the assessment period. In addition, prior experiences, or exposures from other stressors, like the ongoing Zika outbreak could have contributed to the observed effects. Furthermore, potential stigma surrounding depression could potentially lead to social desirability bias, where participants may be reluctant to admit to having depressive symptoms but provide a more socially acceptable response. And finally, the study design limits the ability to access if exposure preceded the reported symptoms of depression. Nevertheless, the literature has validated self-reported assessments to provide some insight into disease occurrence within the population during field investigations (Sun 2021, Evins 2000).

Strengths of this study include the systematic recruitment of participants and the high response of participants taking the in-hospital surveys and completing the subsequent telephone follow-up. In addition, women's experience of the hurricane was assessed in a reasonably short

time post-disaster which provides vital information and potentially favors the recall of events by study participants.

3.8 Public Health Implications

Postpartum depression has been well documented within the literature; however, more research needs to be done for pregnant and postpartum women to receive the necessary care to reduce the associated risk from hurricane exposure. Preparedness planning for disasters should include planning for mental health services for pregnant and postpartum women in post-disaster environments as well as pre-disaster planning should address mental health services that may increase resilience of pregnant and postpartum women facing hurricane disaster, including a social support system to better cope in post-disaster environment.

Future studies should address clinical depression among postpartum persons facing a disaster, screening tools that could be used in a post-disaster situation for clinical intervention as well as examining the role of stigma on reporting postpartum depression by racial and ethnic groups. As findings from this study showed, women were more likely to indicate experiencing a lack of interest in activities postpartum than depressive symptoms. In addition, public health interventions to reduce barriers and improve contraceptives for women and girls continue to be a well-needed intervention as findings from this study supports an association between unintended pregnancies and depressive symptoms.

3.9 Conclusion

Present-day, hurricane disasters are becoming more frequent and intense, and vulnerable populations are most at risk for less-than-ideal outcomes. Considering post-disaster

environments, special care should be considered for vulnerable populations, including pregnant and postpartum women, to ensure their ability to receive the care needed to facilitate their ability to return to pre-disaster conditions. Finally, it is also essential to consider cultural norms and beliefs that hamper many women from obtaining services to promote their health and well-being. Understanding the underlying factors of the mental health challenges impacting different cultures and ethnic groups in program planning and policy implementation can go a long way to making a difference in the lives of pregnant and postpartum women.

3.10 Tables and Figures

Table 3.1. Descriptive characteristics of women delivering a live birth in Puerto Rico post-Hurricanes Irma and Maria. 2017 PRAMS-Zika Postpartum Emergency Response study 2.0

Maternal Characteristics	N (%) 1,230 (100)
Age	
≤19	129 (10.5)
20 - 24	387 (31.5)
25- 34	556 (45.2)
35+	158 (12.9)
Mothers Education	
≤High School Education / GED	338 (27.9)
Some College/ College Degree	717 (58.3)
Post College/ Graduate School	158 (12.9)
Marital Status	
Not married	838 (68.1)
Married	392 (31.9)
Insurance	
Private	383 (31.4)
Public	836 (68.6)
Missing	11 (0.9)
Pregnancy Intent	
Intended	512 (43.6)
Unintended	662 (56.4)
Missing	56 (4.6)
Region	
Urban	476 (38.7)
Rural	754 (61.3)
Social Support	
Complete Support (3 areas)	982 (82.2)
Incomplete Support (0-2 areas)	213 (17.8)
Missing	35 (2.8)

Table 3.2. Self-reported feelings of postpartum depressive symptoms and postpartum lack of interest by hurricane experiences and sociodemographic factors among women delivering a live birth in Puerto Rico Post-Hurricanes Irma and Maria. 2017 PRAMS-Zika Postpartum Emergency Response study

Maternal Characteristics	Postpartum Depressive Symptoms			Postpartum Lack of Interest		
	Always n (%)	Sometimes n (%)	Never n (%)	Always n (%)	Sometimes n (%)	Never n (%)
	46 (4)	192 (16)	985 (80)	98 (8)	221 (18)	903 (74)
Hurricane Experiences						
Life-threatening events						
None	9 (20.0)	29 (15.1)	241 (24.8)	15 (15.3)	33 (15.1)	230 (25.8)
1 to 2 events	18 (40.0)	113 (58.9)	533 (54.8)	49 (50.0)	137 (62.5)	478 (53.6)
3 or more events	18 (40.0)	50 (26.0)	199 (20.5)	34 (34.7)	49 (22.4)	184 (20.6)
Loss of resources						
0 to 1 loss	15 (33.3)	76 (39.8)	526 (53.8)	35 (35.7)	106 (48.4)	475 (53.0)
2 or more loss	30 (66.7)	115 (60.2)	452 (46.2)	63 (64.3)	113 (51.6)	421 (47.0)
Housing Disruption.						
No disruption	16 (34.8)	50 (26.2)	356 (36.6)	29 (29.9)	68 (30.9)	325 (36.4)
1 or more housing disruptions	30 (65.2)	141 (73.8)	618 (63.5)	68 (70.1)	152 (69.1)	568 (63.6)
Challenge Receiving Government Aid						
No	28 (60.9)	129 (67.5)	694 (71.2)	63 (64.3)	149 (68.0)	638 (71.4)
Yes	18 (39.1)	62 (32.5)	281 (28.8)	35 (35.7)	70 (32.0)	256 (28.6)
Age						
≤19	4 (8.7)	25 (13.0)	98 (10.0)	15 (15.3)	26 (11.8)	86 (9.5)
20 - 24	17 (37.0)	57 (29.7)	309 (31.4)	26 (26.5)	85 (38.5)	274 (30.3)
25- 34	17 (37.0)	86 (44.8)	453 (46.0)	42 (42.9)	84 (38.0)	428 (47.4)
35+	8 (17.4)	24 (12.5)	125 (12.7)	15 (15.3)	26 (11.8)	115 (12.7)
Mothers Education						
≤High School Education / GED	16 (34.8)	59 (30.9)	260 (26.4)	25 (25.5)	69 (31.7)	242 (26.6)
Some College and College degree	22 (47.8)	108 (56.2)	583 (59.2)	61 (62.2)	120 (54.3)	530 (58.7)
Post College Degree	8 (17.4)	24 (12.5)	126 (12.8)	12 (12.2)	29 (13.1)	117(13.0)
Marital Status						
Married	12 (26.1)	54 (28.1)	325 (33.0)	28 (28.6)	62 (28.1)	299 (33.1)
Not married	34 (74.0)	138 (71.9)	660 (67.01)	70 (71.4)	159 (72.0)	604 (66.9)
Insurance						
Private	18 (39.1)	65 (33.9)	299 (30.6)	39 (39.8)	64 (29.1)	278 (30.9)
Public	27 (58.7)	126 (65.6)	677 (69.1)	59 (60.2)	152 (69.1)	619 (68.9)
Pregnancy Intent						
Intended	23 (52.3)	57 (31.5)	430 (45.7)	37 (39.4)	71 (32.6)	399 (46.7)
Unintended	21 (47.7)	124 (68.5)	512 (54.4)	57 (60.6)	147 (67.4)	455 (53.3)
Region						
Urban	20 (43.6)	79 (41.2)	376 (38.2)	51 (52.0)	84 (38.0)	341 (37.8)
Rural	26 (56.5)	113 (58.9)	609 (61.8)	47 (48.0)	137 (62.0)	562 (62.2)
Social Support						
Complete Support (3 areas)	31 (68.9)	142 (74.7)	807 (84.2)	71 (74.7)	180 (82.2)	730 (83.1)
Incomplete Support (0-2 areas)	14 (31.1)	48 (25.3)	151 (15.8)	24 (25.3)	39 (17.8)	148 (16.9)

Table 3.3 Unadjusted and adjusted regression models of the association of postpartum depressive symptoms by hurricane experiences and demographic characteristics among women delivering a live birth in Puerto Rico post Hurricanes Irma and Maria. 2017 PRAMS- Zika Postpartum Emergency Response survey 2.0

Maternal Characteristics	Postpartum Depressive Symptoms vs. No Depressive Symptoms[2]	
	Unadjusted POR (95% CI)	Adjusted aPOR (95% CI)
Hurricane Experiences		
Life-threatening events		
None	Ref	Ref
1 to 2 events	**1.56 (1.06, 2.32)**	**1.68 (1.08, 2.61)**
3 or more events	**2.17 (1.4, 3.38)**	**1.83 (1.07, 3.11)**
Loss of resources		
0 to 1 loss	Ref	Ref
2 or more loss	**1.87 (1.39, 2.51)**	**1.62 (1.17, 2.24)**
Housing Disruption.		
No disruption	Ref	Ref
1 to 2 Housing disruption	**1.47 (1.06, 2.04)**	1.31 (0.91, 1.89)
3 or more Housing disruptions	**1.63 (1.04, 2.55)**	1.13 (0.66, 1.92)
Challenge Receiving Government Aid		
No	Ref	Ref
Yes	1.26 (0.93, 1.71)	0.92 (0.64, 1.31)
Age		
≤19	1.21 (0.74, 1.97)	1.10 (0.63, 1.93)
20 - 24	Ref	Ref
25- 34	0.96 (0.69, 1.34)	0.86 (0.58, 1.28)
35+	1.03 (0.65, 1.64)	0.87 (0.50, 1.51)
Mothers Education		
≤ High School Education / GED	Ref	Ref
Some College and College degree	0.71 (0.55, 1.04)	**0.66 (0.45, 0.95)**
Post College Degree	0.87 (0.55, 1.40)	0.68 (0.38, 1.21)
Marital Status		
Married	Ref	Ref
Not Married	1.28 (0.93, 1.75) 0.1	1.4 (0.94, 2.11)
Insurance		
Private	Ref	Ref
Public	0.82 (0.60, 1.10)	**0.59 (0.38, 0.88)**
Pregnancy Intent		
Intended	Ref	Ref
Unintended	**1.47 (1.09, 1.99)**	**1.53 (1.1, 2.12)**
Region		
Urban	Ref	Ref
Rural	0.85 (0.64, 1.14) 0.3	0.89 (0.65, 1.22)
Social Support		
Complete Support (3 areas)	Ref	Ref
Incomplete Support (0-2 areas)	**1.94 (1.38, 2.74)**	**1.63 (1.11, 2.39)**

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[2] Bold results are associations that were found to be significant

Table 3.4 Unadjusted and adjusted regression models of the association of having a lack of interest postpartum by hurricane experiences and demographic characteristics among women delivering a live birth in Puerto Rico post Hurricanes Irma and Maria. 2017 PRAMS- Zika Postpartum Emergency Response survey 2.0.

Maternal Characteristics	Lack of Interest vs. Interest in Activities Postpartum[3]	
	Unadjusted POR (95% CI)	Adjusted aPOR (95% CI)
Hurricane Experiences		
Life-threatening events		
None	Ref	Ref
1 to 2 events	**1.89 (1.32, 2.71)**	**1.94 (1.32, 2.88)**
3 or more events	**2.18 (1.45, 3.28)**	**2.21 (1.36, 3.62)**
Loss of resources		
0 to 1 loss	Ref	Ref
2 or more loss	**1.41 (1.08, 1.82)**	1.19 (0.89, 1.60)
Housing Disruption.		
No disruption	Ref	Ref
1 to 2 Housing disruption	1.22 (0.91, 1.63)	1.07 (0.77, 1.48)
3 or more Housing disruptions	1.54 (1.04, 2.229)	1.07 (0.66, 1.70)
Challenge Receiving Government Aid		
No	Ref	Ref
Yes	1.23 (0.93, 1.62)	0.96 (0.69, 1.34)
Age		
≤19	1.14 (0.74, 1.77)	1.28 (0.79, 2.06)
20 - 24	Ref	Ref
25- 34	**0.72 (0.53, 0.97)**	0.76 (0.53, 1.08)
35+	0.87 (0.57, 1.33)	0.91 (0.55, 1.49)
Mothers Education		
≤ High School Education / GED	Ref	Ref
Some College and College Degree	0.88 (0.66, 1.18)	0.88 (0.61, 1.25)
Post College Degree	0.91 (0.59, 1.41)	0.96 (0.56, 1.64)
Marital Status		
Married	Ref	Ref
Not Married	1.28 (0.97, 1.70)	1.36 (0.96, 1.93)
Insurance		
Private	Ref	Ref
Medicaid/ Public Option	0.91 (0.68, 1.19) 0.5	**0.68 (0.47, 0.98)**
Pregnancy Intent		
Intended	Ref	Ref
Unintended	**1.64 (1.25, 2.15)**	**1.57 (1.17, 2.09)**
Region		
Urban	Ref	Ref
Rural	0.82 (0.63, 1.06)	0.84 (0.63, 1.12)
Social Support		
Complete Support (3 areas)	Ref	Ref
Incomplete Support (0-2 areas)	1.26 (0.91, 1.76)	1.10 (0.76, 1.61)

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[3] Bold results are associations that were found to be significant

Table 3.5. Unadjusted and adjusted models of the association of postpartum depressive symptoms "Always" and "Sometimes" by hurricane experiences and demographic characteristics among women delivering a live birth in Puerto Rico post-Hurricane Irma and Maria. 2017 PRAMS- Zika Postpartum Emergency Response study[4].

Maternal Characteristics	Always Depressive Symptoms vs. No Depressive Symptoms Postpartum		Sometimes Having Depressive Symptoms vs. No Depressive Symptoms Postpartum	
	Unadjusted POR (95% CI)	Adjusted aPOR (95% CI)	Unadjusted POR (95% CI)	Adjusted aPOR (95% CI)
Hurricane Experiences				
Life-threatening events				
None	Ref	Ref	Ref	Ref
1 to 2 events	0.89 (0.39, 2.02)	1.09 (0.44, 2.69)	**1.79 (1.16, 2.78)**	**1.74 (1.07, 2.82)**
3 or more events	**2.37 (1.04, 5.42)**	2.45 (0.88, 6.82)	**2.11 (1.28, 3.47)**	1.58 (0.87, 2.86)
Loss of resources				
0 to 1 loss	Ref	Ref	Ref	Ref
2 or more loss	**2.34 (1.24, 4.41)**	1.80 (0.85, 3.84)	**1.78 (1.29, 2.44)**	**1.56 (1.1, 2.22)**
Housing Disruption				
No disruption	Ref	Ref	Ref	Ref
1 to 2 Housing disruption	0.99 (0.51, 1.91)	0.66 (0.33, 1.32)	**1.63 (1.14, 2.35)**	**1.58 (1.04, 2.39)**
3 or more Housing disruptions	1.33 (0.55, 3.19)	0.53 (0.15, 1.85)	**1.74 (1.06, 2.84)**	1.48 (0.83, 2.61)
Challenge Receiving Government Aid				
No	Ref	Ref	Ref	Ref
Yes	1.62 (0.88, 2.99)	1.03 (0.49, 2.19)	1.18 (0.84, 1.65)	0.88 (0.59, 1.30)
Age				
≤19	0.79 (0.25, 2.41)	0.49 (0.13, 1.84)	1.33 (0.79, 2.25)	1.32 (0.73, 2.39)
20 - 24	Ref	Ref	Ref	Ref
25- 34	0.69 (0.35, 1.39)	0.54 (0.24, 1.25)	1.04 (0.72, 1.49)	1.00 (0.65, 1.54)
35+	1.19 (0.49, 2.85)	1.11 (0.38, 3.28)	0.98 (0.58, 1.66)	0.91 (0.49, 1.67)
Mothers Education				
≤ High School Education / GED	Ref	Ref	Ref	Ref
Some College and College Degree	0.59 (0.31, 1.16)	0.58 (0.24, 1.38)	0.81 (0.56, 1.15)	0.64 (0.40, 1.01)
Post College Degree	1.03 (0.42, 2.50)	0.62 (0.24, 1.58)	0.88 (0.49, 1.40)	0.79 (0.49, 1.26)
Marital Status				
Married	Ref	Ref	Ref	Ref
Not Married	1.4 (0.72, 2.76)	1.86 (0.77, 4.44)	1.24 (0.89, 1.76)	1.29 (0.83, 2.01)
Insurance				
Private	Ref	Ref	Ref	Ref
Public	0.75 (0.39, 1.42)	0.54 (0.19, 1.55)	0.86 (0.63, 1.2)	0.65 (0.42, 1.00)
Pregnancy Intent				
Intended	Ref	Ref	Ref	Ref
Unintended	0.76 (0.41,1.39)	0.73 (0.37, 1.44)	**1.76 (0.4, 0.8)**	**1.82 (1.26, 2.62)**
Region				
Urban	Ref	Ref	Ref	Ref
Rural	0.8 (0.44, 1.46)	0.9 (0.47, 1.72)	0.86 (0.63, 1.19)	0.88 (0.62, 1.26)
Social Support				
Complete Support (3 areas)	Ref	Ref	**Ref**	Ref
Incomplete Support (0-2 areas)	**2.53 (1.31, 4.88)**	**2.32 (1.08, 5.00)**	**1.82 (1.25, 2.64)**	**1.5 (0.05, 0.98)**

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[4] Bolded responses are results that are significant

Table 3.6. Unadjusted and adjusted association of postpartum lack of interest and hurricane experience among women delivering a live birth in Puerto Rico post-Hurricane Irma and Maria. 2017 PRAMS- Zika Postpartum Emergency Response 2.0 survey.

Maternal Characteristics	Lack of Interest vs. Interest in Daily Activities		Sometimes Lack of Interest vs. Interest in Daily Activities[5]	
	Unadjusted POR (95% CI)	Adjusted aPOR (95% CI)	Unadjusted POR (95% CI)	Adjusted aPOR (95% CI)
Hurricane Experiences				
Life-threatening events				
None	Ref	Ref	Ref	Ref
1 to 2 events	1.64 (0.9, 3.0)	1.55 (0.80, 3.01)	**2.01 (1.33, 3.04)**	**1.98 (1.28, 3.11)**
3 or more events	**2.92 (1.54, 5.56)**	**2.52 (1.11, 5.72)**	**1.85 (1.14, 3.01)**	**1.91 (1.10, 3.35)**
Loss of resources				
0 to 1 loss	Ref	Ref	Ref	Ref
2 or more loss	**2.03 (1.31, 3.14)**	**1.63 (1.01, 2.65)**	1.2 (0.89, 1.62)	1.04 (0.75, 1.46)
Disruption in Housing				
No disruption	Ref	Ref	Ref	Ref
1 to 2 Housing disruption	1.17 (0.72, 1.90)	0.89 (0.51, 1.56)	1.24 (0.89, 1.73)	1.2 (0.83, 1.74)
3 or more Housing disruptions	**1.89 (1.03, 3.49)**	1.05 (0.51, 2.19)	1.39 (0.87, 2.22)	1.15 (0.66, 1.98)
Government Aid				
No	Ref	Ref	Ref	Ref
Yes	1.38 (0.89, 2.14)	0.88 (0.5, 1.48)	1.17 (0.85, 1.61)	1.0 (0.69, 1.44)
Age				
≤19	1.87 (0.94, 3.70)	2.29 (1.04, 5.01)	0.94 (0.57, 1.55)	1.0 (0.59, 1.72)
20 - 24	Ref	Ref	Ref	Ref
25- 34	1.05 (0.63, 1.76)	0.52 (0.24, 1.10)	**0.62 (0.4, 0.87)**	0.67 (0.45, 1.0)
35+	1.44 (0.73, 2.84)	0.69 (0.27, 1.77)	0.70 (0.43, 1.15)	0.81 (0.46, 1.43)
Mothers Education				
≤ High School Education / GED	Ref	Ref	Ref	Ref
Some College and College Degree	1.11 (0.68, 1.83)	0.98 (0.57, 1.77)	0.94 (0.64, 1.37)	0.83 (0.56, 1.25)
Post College Degree	0.79 (0.56, 1.11)	0.75 (0.31, 1.88)	0.72 (0.5, 1.04)	1.07 (0.58, 1.95)
Marital Status				
Married	Ref	Ref	Ref	Ref
Not Married	1.29 (0.82, 2.07)	1.77 (0.96, 3.28)	1.27 (0.92, 1.77)	1.16 (0.79, 1.71)
Insurance				
Private	Ref	Ref	Ref	Ref
Public	0.66 (0.43, 1.00)	**0.46 (0.26, 0.83)**	1.17 (0.84, 1.63)	0.94 (0.61, 1.45) 0.8
Pregnancy Intent				
Intended	Ref	Ref	Ref	Ref
Unintended	1.34 (0.87, 2.09)	1.27 (0.81, 1.99)	**1.79 (1.31, 2.46)**	**1.78 (1.27, 2.50)**
Region				
Urban	Ref	Ref	Ref	Ref
Rural	**0.56 (0.36, 0.85)**	**0.58 (0.37, 0.92)**	0.97 (0.72, 1.32) 0.9	0.98 (0.71, 1.36) 0.9
Social Support				
Complete Support (3 areas)	**Ref**	Ref	Ref	Ref
Incomplete Support (0-2 areas)	1.72 (1.05, 2.84) 0.03	1.42 (0.81, 2.47) 0.2	1.08 (0.73, 1.59) 0.7	0.98 (0.64, 1.52) 0.9

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[5] Bold results are associations that were found to be significant

Figure 3.1 Self-reported Hurricane Experiences

Hurricane Experiences PRAMS, ZPER 2.0

- Had trouble dealing with insurance or disaster relief agencies — 19%
- Had trouble getting services or aid from the government — 24%
- Had to move to another municipality — 13%
- Separated from loved ones who you feel close to — 30%
- Lived in temporary housing or in conditions that you were not… — 34%
- Lost personal belongings — 38%
- Had trouble getting enough food to eat — 35%
- Had trouble getting clean drinking water — 42%
- Without electricity for one week or longer — 97%
- Someone close to you died in the disaster — 4%
- Injured or became ill — 10%
- Household member was injured or became ill — 11%
- Walked through debris or floodwater — 30%
- Felt life was in danger — 38%
- Felt unsafe because of the lack of order and security after the… — 61%

Figure 3.2. Categories of self-reported Hurricane Experiences

Hurricane Experiences by Categories

- No Perceived Life threatening Events — 23%
- Some Perceived Life threatening Events — 55%
- Multiple Perceived Life threatening Events — 22%
- Little or No Loss of Resources — 51%
- Multiple Loss of Resources — 49%
- No Disruption in Housing — 35%
- Some Disruption in Housing — 51%
- Multiple Disruption in Housing — 14%
- No Problem Receiving Aid — 70%
- Trouble Obtaining Aid — 30%

58
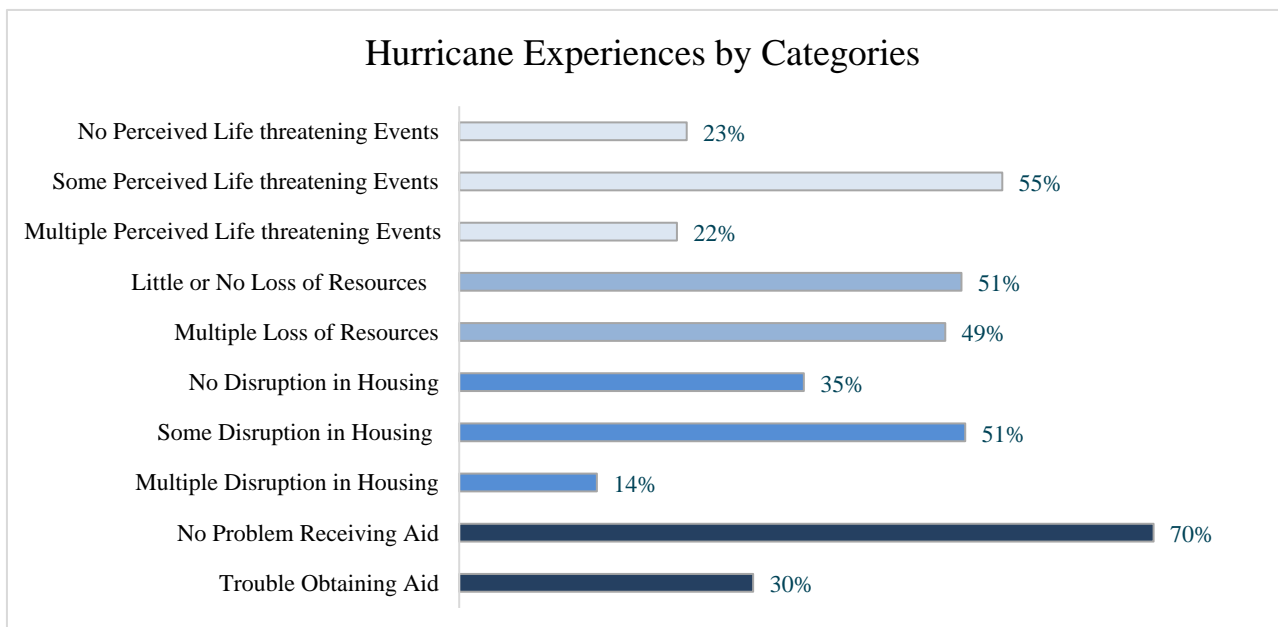
Figure 3.3: Pearson's Correlation of Exposure, Outcome, and Maternal Characteristics

	Depressive Symptoms	Lack of Interest	Age	Education	Married	Insurance	Pregnancy Intent	Urban/ Rural
Depressive Symptoms	1.0000							
Lack of Interest	0.3019	1.0000						
Age	-0.0162	-0.0576	1.0000					
Education	-0.0319	-0.0409	0.4186	1.0000				
Married	0.0447	0.0462	-0.3265	-0.3262	1.0000			
Insurance	-0.0386	-0.0171	-0.4112	-0.3932	0.3693	1.0000		
Pregnancy Intent	0.0803	0.1081	-0.1607	-0.0760	0.1738	0.1215	1.0000	
Urban/ Rural	-0.0278	-0.0410	-0.0387	-0.0455	0.0405	0.1416	-0.0322	1.0000

CHAPTER 4

MANUSCRIPT TWO: ASSOCIATION OF ZIKA PRECAUTIONARY MEASURES AND

ENGAGEMENT IN HURRICANE DISASTER PLANNING AMONG PREGNANT WOMEN

IN PUERTO RICO[1]

4.1 Abstract

Background: In recent years, hurricanes have been increasing in frequency and intensity while previously unknown infectious diseases are emerging worldwide. The overlaying of multiple disasters places pregnant and postpartum women at risk for adverse outcomes. Disaster preparedness planning may help mitigate the risk and enhance the ability to reduce disaster outcomes allowing for a speedy recovery in post-disaster environments. This study investigates whether engagement in preventative measures during the Zika outbreak in Puerto Rico was associated with hurricane disaster planning among women who delivered a live birth in Puerto Rico post-Hurricane Maria.

*Methods***:** We used data from the PRAMS-ZPER 2.0 study that included questions on Zika prevention measures and hurricane preparedness. Zika preventive questions covered mosquito bite prevention, professional mosquito services, and repellent use. Hurricane preparedness questions were categorized and scored to create a Hurricane Preparedness Index. Bivariate and multivariate analyses were conducted using multinomial regression models to assess associations between Zika prevention measures and hurricane preparedness.

*Results***:** Overall, 1,230 participants completed the in-hospital and telephone follow-up surveys. Individuals engaged in two areas of Zika precautionary measures: obtaining professional mosquito services [aPOR 2.0 (1.35, 2.99)] and repellent usage [aPOR 2.57 (1.33, 4.97)] were more likely to have engaged in adequate hurricane disaster planning when compared to those that did not.

Conclusion: We conclude that engagement in Zika preparedness may have influenced engagement in preparedness planning for Hurricanes Irma and Maria. Given their influence on

child, family, and public health, future studies and public health efforts may do well to prioritize

climate disaster preparedness among pregnant and postpartum women.

4.2 Introduction

In recent years, hurricanes have been increasing in frequency and intensity while previously unknown infectious diseases are emerging worldwide. Puerto Rico was hit in 2017 by two class 4 hurricanes within two weeks while combating a major Zika outbreak. These concomitant events placed an undue burden on society, disproportionately impacting economically burdened individuals, socially isolated, disabled, and pregnant and postpartum women. Overall, women are increasingly vulnerable to post-disaster psychological effects due to anxiety and depression (WHO 2002, Tee 2010, Buttnell 2009). Pregnant and postpartum women's needs are often overlooked, leaving them exposed and vulnerable to post-disaster psychological distress, mental health disorders, maternal distress, and the potential for increased risk for substance abuse (Hung, 2018; Lauve-Moon, 2017).

Disaster preparedness planning may help mitigate the risk and enhance individuals' and the communities' ability to reduce adverse disaster outcomes by increasing resilience and speedy recovery in the post-disaster environment (Swickert 2009; Vogt 2008). The impact of hurricanes varies among persons of different sociodemographic levels. Individuals from vulnerable groups, such as the poor, the elderly, and pregnant women, face a greater burden from disaster and are more likely to be unprepared when facing a disaster. Minority women and those with less education have a greater chance of having more negative outcomes, experiencing severe loss, or being impacted by injuries and illnesses during the disaster (Harville 2009). In contrast, white, married, educated, and individuals with higher income were more likely to engage in disaster preparedness activities that lessened the severity of the disaster while increasing resilience in returning to pre-disaster normalcy (Zilversmit 2014, Martins 2018).

FEMA's 2015 Disaster Preparedness Behavior profile showed that 44% of Hispanics have supplies at home compared to 56% among whites. Only 32% of Hispanic households had a disaster plan vs. 44% among whites. Similarly, only 26% of Hispanic households were enrolled in a community warning program compared to 57% among whites. Overall, in the United States, disaster planning preparedness was not on the radar of 59% of Hispanic households, compared to 45% of whites.

FEMA's survey of Preparedness in American Households reported that on average, 70% of households are engaged in at least one preparedness act, 39% had a plan that was shared with their family, 52% had supplies set aside for disaster, and 23% indicated to have some form of training to aid during or after a disaster had occurred (FEMA 2015). Homes with shared preparedness plans produced by their children's schools were 75% more likely to engage in preparedness activities. In contrast, homes with children under 18 also had a higher likelihood of engaging in emergency planning (Basolo 2009, McNeill 2017). Additionally, living in disaster-prone areas is a predictor of increased engagement in preparedness activities (Selvaraj 2019, Semien 2019).

As disasters become more commonplace, the convergence of multiple disasters in communities has highlighted individual and communities' vulnerabilities. Such occurrences have reinforced the need to develop a culture of preparedness, not just a seasonal or a one-time single approach. In 2017, Puerto Rico experienced multi-catastrophic events with back-to-back disastrous hurricanes that left most of the population without power, water, shelter, and a stable source of food for months (Meyer 2018, NWS 2018, Rudner 2018). These hurricanes hit Puerto Rico while battling a major Zika virus outbreak.

4.3 Zika Outbreak in Puerto Rico

Zika, a mosquito-borne flavivirus, arrived in Puerto Rico in late 2015. Infections from the virus continued through 2017, impacting many Caribbean countries, including Central and South America. Puerto Rico was the hardest-hit US jurisdiction, with over 35,000 infected including, 3,300 pregnant women (CDC 2016, Dept of Salud 2017).

The Zika virus is spread through bites of the *Aedes* mosquitoes that steadily made its way through Yap Island, Micronesia, to other South Pacific islands in the late 2000s, rapidly evolving into a declaration of a Public Health Emergency of International Concern by the WHO in 2015 when it arrived in South America. Zika quickly spread to Central America, Mexico, the Caribbean, and Puerto Rico (Duffy 2009, Pastula 2016). While the Zika virus infection is asymptomatic in about 80% of individuals, it poses serious risks to infected pregnant women. Their infected fetus may develop severe birth defects such as microcephaly and severe brain abnormalities that may result in developmental disabilities and other adverse pregnancy outcomes, such as preterm births (Brasil 2016, CDC 2020a). The developmental disabilities resulting from maternal Zika infections often lead to long-term health care needs (CDC 2020e). In the absence of a Zika vaccine, prevention of mother-to-child transmission focuses on interventions to minimize mosquito bites. Therefore, the prevention efforts implemented across the island focused on mosquito control and measures to reduce the rates of unintended pregnancy (Earle-Richardson 2018, Filgueiras 2017, Hennessey 2016, Kortsmit 2020).

The Department of Health provided Zika Prevention Kits containing repellent, larvicide, bed nets, and condoms at no cost to pregnant women (HHS 2016, Earle-Richardson 2018). Additional interventions provided through Women, Infant, and Child (WIC) clinics including Zika informational videos and providing professional mosquito spraying services free of charge

upon request. This effort was launched in tandem with behavior modification campaigns like "Detén el Zika/ Stop Zika," a media campaign providing information on the removal of standing water, use of larvicide, and other methods to control the mosquito population to interrupt Zika transmission (CDCF 2016, CDCF 2020, August 2020). High engagement was observed in the removal of standing water (90%) and lower in the application of larvicide (40%), and in the installation of windows or door screens (18%) (Earle-Richardson 2018).

Collaboration with the CDC Foundation and the Puerto Rico Department of Health led to the Zika Contraception Access Network (Z-CAN) implementation. An initiative to provide contraceptives to women at no cost to prevent unintended pregnancies. In the early 2000s, unintended pregnancies accounted for 66% of pregnancies in Puerto Rico compared to 51% in the U.S. population, one of the highest in the U.S. and among its territories, making it a public health concern, and even more so during the Zika pandemic (Tepper 2016, Hamilton 2014).

4.4 Hurricane Maria

While still battling the Zika pandemic, Puerto Rico, was hit by two Class 4 hurricanes within two weeks. First, Hurricane Irma caused significant damage in Puerto Rico, followed by Hurricane Maria, before recovery from the first hurricane could be fully implemented. Hurricane Maria made landfall in Puerto Rico, with sustained winds of 155 mph, leading to catastrophic flooding and severe disruption of most essential services, including power, water service, and wireless communications. Nearly five years later, recovery is still ongoing. (NWS 2019). Hurricane Maria has been recorded as one of the worst and deadliest storms in the Atlantic since Hurricane Georges in 1998 (Sattler 2019).

4.5 Hurricane Disaster Preparedness

Hurricane disaster preparedness activities may enhance individual and community's ability to minimize the impact of the disaster while improving the capacity to return to pre-disaster normalcy (Ehrlick 2010). Disaster planning measures, including discussing plans with family members and having essential supplies of medications, water, and food, are some of the recommendations to prepare in the case of a hurricane disaster (DHHS, 2020)

There is limited experience on hurricane preparedness among the pregnant and postpartum population. Furthermore, studies about disaster preparedness focus on single disaster events. Thankfully, the combination of climatic disasters and a major epidemic is rare but offers a unique opportunity to address interactions between the simultaneous Zika epidemic and hurricane disasters. This study examines the potential association of Zika preventative measures and its possible association with hurricane preparedness among pregnant women in Puerto Rico. In specific, we examined the association between Zika preventative measures and hurricane preparedness by asking the question: Is the engagement in Zika preventative measures associated with hurricane disaster planning among pregnant women in Puerto Rico?

4.6 Methods

Data Collection

We utilized the Pregnancy Risk Assessment Monitoring System-Zika Postpartum Emergency Response Survey (PRAMS-ZPER) 2.0 conducted in Puerto Rico in the Fall of 2017 following hurricanes Irma and Maria among women who delivered a live birth in Puerto Rico. Data collection occurred in two phases, an in-hospital interview conducted from November to December 2017, then a telephone follow-up survey in February 2018 to March 2018. The in-

hospital survey collected data on Zika preventative measures, and the telephone survey included questions on hurricane preparedness. While PRAMS – ZPER 2.0 had a cross sectional analysis with data collected in a prospective manner as the hurricane preparedness questions were collected at a second timepoint.

The PRAMS-ZPER study was an island-wide stratified survey designed to assess pregnant women's behaviors during the Zika virus outbreak and experiences following hurricanes Irma and Maria. Survey participants were selected from participating hospitals with at least 100 births per year. Thirty-four (34) hospitals were eligible to participate. The PRAMS-ZPER 2.0 in-hospital data collection occurred post-delivery during the mother's hospital stay. A telephone follow-up survey was conducted about three months later. Only women completing the in-hospital surveys were eligible for the telephone follow-up survey. For this study, we used specific questions from the PRAMS-ZPER 2.0 in-hospital survey to access exposure measures engagement in Zika prevention and questions from the telephone follow-up survey in the spring of 2018 to examine outcome of interest, participation in hurricane preparedness planning.

A total of 30 hospitals participated in the PRAMS-ZPER 2.0 survey representing 96.2% of all live births in Puerto Rico. Four hospitals did not participate in the study, three due to damages sustained from the hurricane, and one hospital in the San Juan metropolitan area did not agree to participate (CDC 2020).

Study participants were selected from women admitted to a participating hospital during the study period from November to December 2017 who delivered a live-born infant and agreed to participate in the survey. Overall, 1,545 women were selected to participate in the PRAMS-ZPER 2.0 in-hospital study, 1,482 completed the in-hospital survey, and 1,230 completed the telephone follow-up interviews 3-4 months postpartum (D'Angelo 2017).

Birth certificate information was matched following the in-hospital study, and a letter was mailed to study participants informing them of the upcoming telephone survey. More detailed information regarding the PRAMS-ZPER survey process can be found on the CDC PRAMS website [PRAMS Zika Postpartum Emergency Response Survey (PRAMS-ZPER) in Puerto Rico](). (CDC 2020)

4.7 Measures

Exposure Variable: Zika Prevention Measures

To evaluate preventive measures, we assessed participants' responses to three groups of survey questions from the in-hospital survey related to mosquito bite prevention: (1) mosquito bite prevention at home, (2) use of professional mosquito control services, and (3) repellent use in the skin or clothing. The first question, mosquito bite prevention at home, included six items, the second question, professional mosquito services, included three items, and the response on mosquito repellent use was categorized into sometimes, rarely, and never. Mosquito bite prevention at home items were scored based on zero if not done, and one for yes. The six responses were summed, resulting in responses that ranged from zero (no engagement) to six (high engagement). Only 18 (1.6%) had zero in this category and were combined with those engaged in one area and classified as "limited engagement." A score of "2 to 3" was classified as "some engagement," and a score of "4" or more was classified as "adequate engagement."

Professional mosquito services items were dichotomized to create a binary variable with "0" representing no professional mosquito services and "1" receiving one or more professional mosquito services. The use of mosquito repellent was categorized as always, sometimes, rarely,

and never. Responses rarely and never were combined in a category to represent a lack of engagement in repellent use.

Outcome Variables: Household Disaster Preparedness

We created a preparedness index for hurricane preparedness based on participants' responses to eight disaster preparedness questions in the PRAMS-ZPER 2.0 telephone follow-up survey (*See* Figure 4.1). The eight questions were grouped into three categories by type of preparedness activities: (1) family disaster planning, (2) evacuation planning, and (3) family supplies (Zamboni 2020, Thomas 2015). Family disaster planning included four questions: having a family meeting place, family engagement in disaster practice drills, having a plan to keep in touch, and securing essential documents. Evacuation planning included two questions: having an overall evacuation plan and having a child evacuation plan. The category family supplies included two questions: having emergency supplies at home and having emergency supplies away from home.

The items within each category were summed to create a composite index score and dichotomized to create a binary outcome of zero for not engaging in any of the items within the category and one for engagement in at least one item within the category (Al-Roussan 2015). Therefore, the sum of the three categories yielded composite scores of 0 to 3. Zero was classified as no engagement in any hurricane disaster planning through "3" engaging in all three areas. Given that the number of participants engaging in no planning "0" was only 17 (1.4%), we combined it with those with one "1" planning area classified as "limited planning." Those with engagement in 2 planning areas we classified as "Moderate Planning," and engagement in all three planning areas, was classified as adequate planning.

70

Covariates

Demographic characteristics included in the analysis were age, education level, marital status, pregnancy intent, insurance, WIC participation, and area of residence (rural vs. urban). Age was categorized as ≤19, 20-24, 25-34, 35+. Education had three categories: less than high school education/ high school graduate or GED, some college or college degree, and graduate degree. Pregnancy intent was categorized into intended pregnancy if the respondent indicated they wanted to be pregnant then or sooner and unintended pregnancy if respondents did not want to be pregnant, wanted to be pregnant later, or were unsure of what they wanted. Insurance was categorized into Private if insurance was obtained from a job, parents or brought and Public if on Medicaid to include a public option and no insurance. Those indicating to have no insurance were less than 1% [n=9 (0.6%)] and was removed from the analysis. Place of residence was categorized into urban and rural, with urban if the population was ≥70,000k and Rural if <70,000.

4.8 Statistical Analysis

We conducted a univariate analysis of demographic factors: mother's age, education, marital status, pregnancy intent, WIC participation, insurance, and region of residence (urban/rural). That analysis was followed by Pearson correlations, to examine correlation among exposure and outcome variables. Bivariate and multivariate analyses were conducted to examine the association of the exposure variable-Zika precautionary measures - (a) mosquito bite prevention, (b) use of professional mosquito services, and (c) repellent usage, and the outcome of interest hurricane preparedness planning. We used multinomial logistic regression model to investigate the relationships and to obtain the unadjusted prevalence odds ratio (POR), adjusted

prevalence odds ratio (aPOR) and 95% confidence interval. Regression models were carried out

to assess first, "Planning in Multiple Areas vs. Limited Disaster Planning" and, second model

assessing "Moderate Disaster Planning vs. Limited Disaster Planning. Each adjusted model

included all covariates in each model and test for collinearity among the variables using the

Variance Inflation Factor (VIF). Statistical analytical weight was also applied that was calculated

based on an adjustment factor of 1.054. This was based on estimates of declining birth rates

since 2007. For further information on the development of the adjustments made, the full report

on the ZPER 2.0 sampling protocol can be found at https://omb.report/icr/201708-0920-

008/doc/76047901. Statistical analyses were carried out using STATA 16.1.

4.9 Results

A total of 1,545 women were selected to participate in the PRAMS-ZPER 2.0 study, with

1,482 completing the in-hospital surveys and 1,230 completing the telephone follow-up

interviews 3-4 months postpartum in the Spring of 2018, representing 83% completion. Those

ages 25-34 were the most prevalent age group represented at 45%. More than half of the

participants (58%) had a college degree or some college education, 68% were unmarried, with

85% identified as WIC participants. Most of the women, 68%, were enrolled in Medicaid to

include a public option and 61% indicated living in rural communities.

Of those indicated to have engaged in disaster preparedness activities, 52% were

categorized as having adequate planning, 33% moderate planning, and 15% engaged in limited

planning activities. Overall, engagement in 2 of the 3 Zika precautionary areas, receiving

professional mosquito services, and the use of repellent was shown to be significant among those

engaged in multiple disaster planning but not among the mosquito bite prevention group. Those

receiving professional mosquito services were more likely to engage in disaster planning than

those who did not [aPOR 1.72 (1.18, 2.52)]. Those indicating always using repellent [aPOR 2.41 (1.31, 4.41)] and those that use repellent sometimes [aPOR 1.83(1.01, 3.35)] were more likely to engage in multiple disaster planning efforts when compared to those indicating to rarely or never use repellent. WIC participants were twice as likely to engage in multiple disaster planning efforts when compared to non-WIC participants [aPOR 2.00 (1.16, 3.46)]. Age, education, marital status, pregnancy intent and region of residence, did not show an association that was significant to hurricane disaster planning (Table 4.3).

The adjusted multivariate regression models (Table 4.4) comparing moderate planning and adequate planning to limited disaster planning showed an association of Zika precautionary measures in 2 of the 3 areas. In the moderate planning model, using repellent as a Zika precautionary measure was associated with the engagement in moderate disaster planning compared to those that rarely or never used repellent [aPOR 2.25 (1.14, 4.42)]. The Adequate disaster planning model found those engaged in 2 areas of Zika precaution measures- always using professional mosquito service [aPOR 2.0 (1.35, 2.99)] and repellent usage [aPOR 2.57 (1.33, 4.97)] to be a predictor of adequate disaster planning as compared with those that did not use professional mosquito services and those that never or rarely used repellent on clothes or skin when going outdoors. WIC participants were more than twice as likely to engage in adequate disaster planning than non-WIC participants [aPOR 2.29 (1.28, 4.07)]. However, individuals on Medicaid to include a public option had a lower prevalence of engaging in adequate disaster planning activities than those enrolled in private insurance. Marital status, pregnancy intent, WIC and region, did not show to be significant in Moderate vs limited planning or Adequate vs. Limited planning models. Pearson correlation check for linear

correlations among covariates were conducted and noticed that WIC and insurance are strongly correlated so insurance was removed.

4.10 Discussion

Our study is unique as we assess Zika preventative measures' engagement and the association with hurricane disaster preparedness among women who delivered a live birth in Puerto Rico post Hurricanes Irma and Maria. The findings from this study suggest that engagement in preventative measures during the Zika virus outbreak is associated with the engagement in preparedness in a subsequent disaster, Hurricanes Irma, and Maria. When looking at hurricane disaster planning in multiple areas, there was a clear impact among the engagement in professional mosquito services and repellent usage but not the same level of significance for those engaging in mosquito bite prevention which included the use of screens on doors and windows. Screens were highly recommended but showed less uptake within the population (Earle-Richardson 2018). The cost of screens on windows and doors has been identified as a potential barrier compared to other interventions (ACF 2016).

Engagement in two of the three Zika precautionary measure areas, receiving professional extermination services and repellent, was associated with higher odds of hurricane disaster planning engagement. WIC participants had a higher engagement in adequate disaster planning among our population. However, our data is not sufficient to adequately assess this relationship as we are unable to differentiate the participants that received professional mosquito services from WIC and those that did not.

The findings from this study are subjected to some limitations. First, the data is limited to women in Puerto Rico that delivered a live birth during the study period and may not be

generalizable to other communities that experienced Zika outbreak and hurricane disasters. Another limitation is that among the mosquito bite prevention group, of which included using screens on their doors and windows as well as bed nets. Individuals that engaged in limited planning (n=16) and moderated planning (n=25), suffered from small sample size, and we might not be able to obtain a relationship of significance when examining the association to disaster planning. Also, we are unable to identify the individuals that had screens before Zika than those that installed or fixed the screens that already exist within their home as a behavior modification effort to prevent Zika transmission. Finally, the design of the study potentially suffers from bias as one data was collected before the other. This might lead to a more conservative or underestimation of the observed association. Despite these study limitations, this is the first study we know to assess disaster planning efforts across different disaster types.

Strengths of this study include the systematic recruitment of participants and the high participation of pregnant women that completed the in-hospital survey and the telephone follow-up. In addition, the study was conducted in a short time related to the occurrence of the disasters, potentially favoring recall among the study population.

4.11 Public Health Implications

This study explored the response and actions taken to prevent serious infections from the Zika virus outbreak and suggests that preparation for one type of disaster may increase likelihood of preparation for other disaster types. Disaster planning needs to address pregnant and post-partum women needs, including consideration to factors that may increase resiliency as well as process to reach those that are not engaged in disaster planning activities.

Understanding health behavior patterns among pregnant and postpartum women can help inform public health initiatives to be better prepared in the event of a disaster. With disasters becoming more commonplace, public health must build a culture of preparedness to adequately address these emerging needs.

Furthermore, additional research is needed to explore the synergistic effects of attitudes and behaviors among individuals that experience multiple disaster occurrences. The PRAMS-ZPER 2.0 provides a rich data source across two major disasters within the same population. This unique circumstance data on a topic that, to our knowledge, has not been investigated before.

Future studies should examine contributing factors to increase engagement with different types of disasters, specifically, factors that lead to no disaster planning and explore approaches on how to reach populations with little or no disaster planning to enhance likelihood of disaster preparedness within such groups.

During the Zika pandemic, the WIC program was an active participant in promoting Zika precautions among pregnant women. Further studies should consider WIC's impact in disseminate information during crises and explore WIC's impact on hurricane disaster planning efforts as well as a trusted source of information among pregnant and postpartum women. Insights into how we communicate with the pregnant population before, during, and after a disaster is crucial to addressing current and future disaster is urgently needed.

4.12 Conclusion

The impact of Zika and Hurricanes Irma and Maria in Puerto Rico in 2017 was one of the more tragic combinations of disasters to impact the Caribbean region. The devastation

highlighted challenges to Puerto Rico's infrastructure, stretched healthcare, and economic system

and the impact on vulnerable populations to include pregnant and postpartum women. The

PRAMS-ZPER study gave us a unique opportunity to examine emergency planning among

pregnant and postpartum women. Understanding the challenges faced in this area can help

policy makers to design interventions geared towards behavior modification in the face of

disaster is essential to establishing programs and strategies so individuals can have the tools

needed to incorporate preventative measures in their daily lives. For pregnant and postpartum

women, this is essential for their mental health and well-being, resilience post-disaster and a

speedier return to post-disaster normalcy.

4.13 Tables and Figures

Table 4.1. Descriptive characteristics of women that delivered a live birth in Puerto Rico following Hurricane Irma and Maria. 2017 PRAMS- Zika Postpartum Emergency Response Survey 2.0

Characteristics	N (%) 1,230 (100)
Age	
≤19	129 (10.5)
20- 24	387 (31.5)
25- 34	556 (45.2)
35+	158 (12.9)
Education	
≤High School Education / GED	338 (27.9)
Some College/ College Degree	717 (58.3)
Post College/ Graduate School	158 (12.9)
Marital Status	
Not Married	838 (68.1)
Married	392 (31.9)
Pregnancy Intent	
Intended	662 (56.4)
Unintended	512 (43.6)
Missing	56 (4.6)
WIC	
No	181 (14.8)
Yes	1,045 (85.2)
Missing	4 (0.3)
Insurance	
Private	383 (31.3)
Public	836 (68.2)
Missing	11 (0.9)
Region	
Urban	476 (38.7)
Rural	754 (61.3)

Table 4.2. Distribution of Zika Precautionary Measures and Hurricane Preparedness Planning among postpartum women that delivered a live birth in Puerto Rico following Hurricane Irma and Maria. 2017 PRAMS- Zika Postpartum Emergency Response Survey 2.0

Characteristics	Sample Size N (%) 1,230 (100)	Limited Planning n (%) 182 (15)	Moderate Planning n (%) 403 (33)	Adequate Planning n (%) 628 (52)
Mosquito bite prevention				
Little or no engagement	77 (7.06)	16 (10.1)	25 (7.1)	34 (6.0)
Moderate engagement	399 (36.6)	63(39.6)	144 (40.8)	188 (33.3)
High engagement	615 (56.4)	80 (50.3)	184 (52.1)	343 (60.7)
Professional mosquito services				
No	396 (34.7)	78 (45.6)	148 (40.2)	165 (28.1)
Yes	745 (65.3)	93 (54.4)	220 (59.8)	422 (71.9)
Repellent Usage				
Rarely/never	98 (8.0)	24 (13.4)	34 (8.5)	37 5.9)
Sometimes	424 (34.7)	73 (40.6)	145 (36.2)	200 (32.1)
Always	699 (57.3)	83 (46.1)	221 (55.3)	387 (62.0)

Table 4.3. Unadjusted and Adjusted models of the association of Zika precautionary measures and hurricane preparedness planning among postpartum women that delivered a live birth in Puerto Rico following Hurricane Irma and Maria of those engaged in limited disaster planning and planning in multiple areas. 2017 PRAMS-ZPER 2.0

| | Planning in Multiple Areas vs. Limited Planning | | | |
| | Unadjusted | | Adjusted | |
Characteristics	POR	(95% CI)	aPOR	(95% CI)
Mosquito bite prevention				
Little or no engagement		Ref		Ref
Moderate engagement	1.39	(0.75, 2.60)	1.14	(0.59, 2,20)
High engagement	1.72	(0.94, 3.17)	1.37	(0.72, 2.65)
Professional mosquito services				
No		Ref		Ref
Yes	**1.72**	**(1.23, 2.39)**	**1.72**	**(1.18, 2.52)**
Repellent Usage				
Rarely/never		Ref		
Sometimes	1.54	(0.91, 2.62)	**1.83**	**(1.01, 3.35)**
Always	**2.41**	**(1.43, 4.06)**	**2.41**	**(1.31, 4.41)**
Age				
≤ 19	1.06	(0.61, 1.84)	0.76	(0.40, 1.43)
20- 24		Ref		Ref
25- 34	1.24	(0.87, 1.79)	1.51	(0.95, 2.38)
35+	1.28	(0.75, 2.18)	1.34	(0.68, 2.62)
Education				
≤High School Education / GED		Ref		Ref
Some College/ College Degree	1.02	(0.70, 1.48)	0.84	(0.53, 1.34)
Post College/ Graduate School	0.89	(0.53, 1.52)	0.78	(0.38, 1.57)
Marital Status				
Married		Ref		Ref
Not Married	0.99	(0.71, 1.39)	0.87	(0.55, 1.38)
Pregnancy Intent				
Intended		Ref		Ref
Unintended	0.9	(0.65, 1.26)	0.95	(0.64, 1.38)
WIC				
No		Ref		Ref
Yes	1.43	(0.95, 2.16)	**2.00**	**(1.16, 3.46)**
Region				
Urban		Ref		Ref
Rural	1.08	(0.78, 1.49)	1.12	(0.53, 4.14)

Table 4.4. Unadjusted and Adjusted Association of Zika Precautionary Measures and Hurricane Preparedness Planning among postpartum women that delivered a live birth in Puerto Rico following Hurricane Irma and Maria. 2017 PRAMS- Zika Postpartum Emergency Response Survey 2.0

Characteristics	Moderate Hurricane Planning vs. Limited Planning		Adequate Hurricane Planning vs. Limited Planning	
	Unadjusted POR (95% CI)	**Adjusted** aPOR (95% CI)	**Unadjusted** POR (95% CI)	**Adjusted** aPOR (95% CI)
Mosquito bite prevention				
Little or no engagement	Ref	Ref	Ref	Ref
Moderate engagement	1.43 (0.71, 2.89)	1.118 (0.57, 2.45)	1.36 (0.70, 2.66)	1.11 (0.55, 2.23)
High engagement	1.44 (0.72, 2.86)	1.19 (0.57, 2.47)	**1.93 (1.01, 3.71) 0.04**	1.56 (0.78, 3.11)
Professional mosquito services				
No	Ref	Ref	Ref	Ref
Yes	1.24 (0.86, 1.79)	1.34 (0.88, 2.03)	**2.14 (1.51, 3.05)**	**2.0 (1.35, 2.99)**
Repellent Usage				
Rarely/never	Ref	Ref	Ref	Ref
Sometimes	1.36 (0.75, 2.47)	1.8 (0.9, 3.5)	1.7 (0.95, 3.05)	1.85 (0.96, 3.59)
Always	**1.36 (1.04, 3.35)**	**2.25 (1.14, 4.42)**	**2.91 (1.64, 5.14)**	**2.57 (1.33, 4.97)**
Age				
≤19	1.05(0.56, 1.97)	0.65 (0.31, 1.35)	1.07 (0.59, 1.89)	0.79 (0.40, 1.56)
20- 24	Ref	Ref	Ref)	Ref
25- 34	1.47 (0.98, 2.21)	**1.75 (1.05, 2.9)**	1.12 (0.76, 1.63)	1.32 (0.82, 2.13)
35+	1.36 (0.75, 2.49)	1.50 0.72, 3.13)	1.22 (0.69, 2.14)	1.29 (0.65, 2.55)
Education				
≤High School Education / GED	Ref	Ref	Ref	Ref
Some College/ College Degree	1.07 (0.71, 1.62)	0.86 (0.52, 1.44)	0.98 (0.67, 1.46)	0.83 (0.51, 1.34)
Post College/ Graduate School	1.11 (0.62, 1.98)	0.91 (0.42, 1.93	0.77 (0.44 1.34)	0.68 (0.32, 1.45)
Marital Status				
Married	Ref	Ref	Ref	Ref
Not Married	0.98 (0.67, 1.43)	0.95 (0.58, 1.56)	1.00 (0.70, 1.43)	0.79 (0.49, 1.28)
Pregnancy Intent				
Intended	Ref	Ref	Ref	Ref
Unintended	0.84 (0.58, 1.20)	0.89 (0.59, 1.34)	0.95 (0.68, 1.34)	1.04 (0.7, 1.53)
WIC				
No	Ref	Ref	Ref	Ref
Yes	1.09 (0.69, 1.72)	1.53 (0.86, 2.72)	**1.75 (1.13, 2.75)**	**2.29 (1.28, 4.07)**
Region				
Urban	Ref	Ref	Ref	Ref
Rural	0.96 (0.67, 1.37)	1.02 (0.66, 1.57)	1.16 (0.82, 1.63)	1.16 (0.77, 1.75)

Supplemental Table

Table 4.5: Hurricane Preparedness Planning by Sociodemographic characteristics among postpartum women that delivered a live birth in Puerto Rico following Hurricane Irma and Maria. 2017 PRAMS- Zika Postpartum Emergency Response Survey 2.0

Characteristics	Sample Size N (%) 1,230 (100)	Limited Planning n (%) 182 (15)	Moderate Planning n (%) 403 (33)	Adequate Planning n (%) 628 (52)
Age				
≤19	129 (10.5)	20 (10.9)	38 (9.4)	68 (10.8)
20- 24	387 (31.5)	64 (35.2)	113 (28.0)	202 (32.2)
25- 34	556 (45.2)	77 (42.3)	201 (49.9)	274 (43.6)
35+	158 (12.9)	21 (11.5)	51 (12.7)	84 (13.4)
Education				
≤High School Education / GED	338 (27.9)	48 (26.7)	104(26.1)	177 (28.9)
Some College/ College Degree	368 (30.3)	42 (23.3)	132 (33.1)	189 (30.6)
Post College/ Graduate School	507 (41.8)	90 (50.0)	163 (40.9)	251 (40.7)
Marital Status				
Not Married	838 (68.1)	123 (67.6)	273 (67.7)	426(67.8)
Married	392 (31.9)	59 (32.4)	130 (32.3)	202(32.2)
Pregnancy Intent				
Intended	662 (56.4)	73 (41.7)	175 (45.8)	257(42.7)
Unintended	512 (43.6)	102 (58.3)	207 (54.2)	345(57.3)
WIC				
No	181 (14.8)	34 (18.7)	70(17.5)	75 (12.0)
Yes	1,045 (85.2)	148 (81.3)	331(82.5)	551(88.0)
Insurance				
Private	383 (31.3)	58 (31.9)	129 (32.1)	192(30.8)
Public	836 (68.2)	123 (67.6)	270(67.2)	430(68.9)
Region				
Urban	476 (38.7)	73 (40.1)	166 (41.2)	231(36.8)
Rural	754 (61.3)	109 (59.9)	237(58.8)	397(63.2)

Figure 4.1 Hurricane Preparedness Index
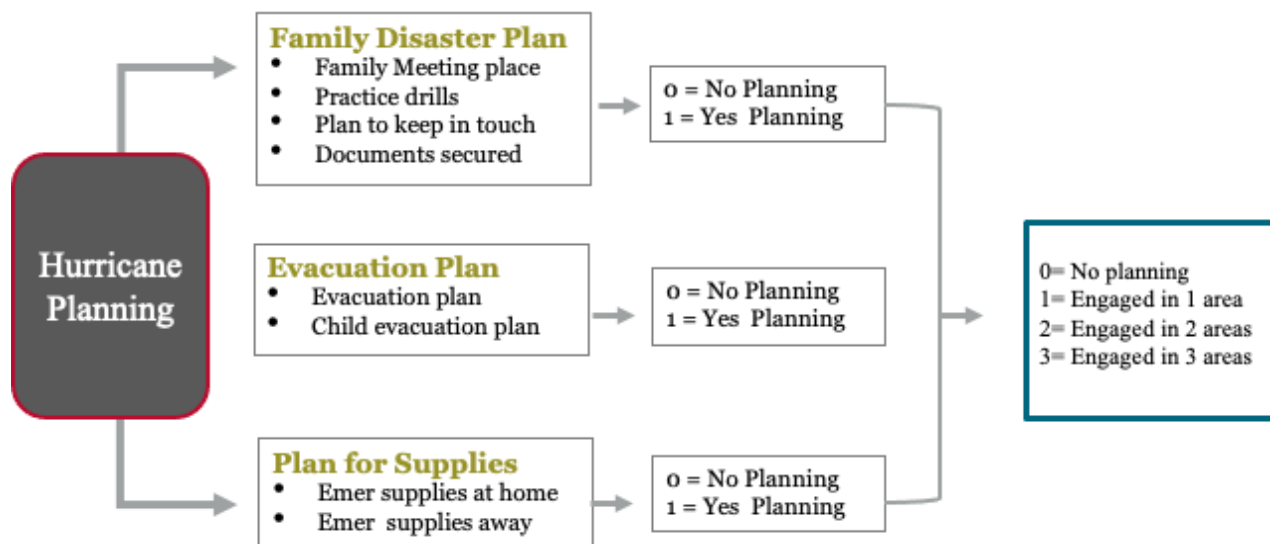
Figure 4.2: Pearson's Correlation of Exposures, Outcomes and Maternal Characteristics

	Planning	zika_prec	repellent	spray	age	education	married	preg_intent	WIC	Insurance	Urban-rural
Planning	1.0000										
zika_prec	0.0909	1.0000									
repellant	-0.0098	-0.0773	1.0000								
spray	0.1627	0.1786	-0.0600	1.0000							
age	0.0049	-0.0042	0.0118	-0.0086	1.0000						
education	-0.0380	0.0458	0.0440	-0.0811	0.4186	1.0000					
married	0.0018	-0.0232	0.0284	0.0548	-0.3265	-0.3262	1.0000				
preg_intent	0.0049	-0.0224	0.0003	-0.0242	-0.1607	-0.0760	0.1738	1.0000			
WIC	0.0789	0.0251	-0.0695	0.0599	-0.2388	-0.2178	0.2471	0.0864	1.0000		
Insurance	0.0124	-0.0456	-0.0366	0.0679	-0.4112	-0.3932	0.3693	0.1215	0.4078	1.0000	
Urban-rural	0.0343	0.0520	-0.0366	0.0324	-0.0387	-0.0455	0.0405	-0.0322	0.169	0.141	1.000

CHAPTER 5

DISCUSSION

5.1 Hurricane Experiences and Mental Health

Findings from this study indicate hurricane experiences are associated with depression

and a lack of interest in postpartum among women delivering a live birth in Puerto Rico post-

Hurricanes Irma and Maria. Specifically, as it relates to experiencing perceived life-threatening

events and a loss of resources that of which included having access to food, cleaning water, and

utilities post hurricane. This association was not observed among those experiencing housing

disruptions like moving to another municipality or damage sustained to their property. Findings

from our study are similar to previous studies that have shown an association between hurricane

experiences and depression post-hurricane disaster in New Orleans following Hurricane Katrina.

(Ehrlick 2010).

Our findings on depressive symptoms are significantly lower than other post-hurricane

disaster studies. One study found depressive symptoms in 18% of postpartum women in New

Orleans (Harville 2009). Another study assessed maternal stress and infant temperament post-

Hurricane Katrina depression as high as 24% in the study population (Tees 2009). Depressive

symptoms could be underrepresented in our study population as the stigma surrounding

depression lends to women's reluctance to admit their experiences but rather provide a socially

acceptable response as they might associate depression with someone that needs to be

institutionalized (NIMH 2011, Backstrom et al. 2009).

When discussing depression, postnatal or otherwise, we must acknowledge the

85

underlying stigmas (McLoughlin 2013, Crisp 2000). One study found that women were fearful of a postpartum depression diagnosis as it is viewed as a sign of weakness and an indication of her inability to cope as a mom (Edge 2006, Bitszta 2010). Another study of Hispanic women revealed feelings of guilt and shame, that "they should be able to handle everything" as a mom and were reluctant and embarrassed to share their feelings with family or even their healthcare providers (Callister 2011).

Research has shown that postpartum depression is under-detected by healthcare providers (Callister 2011, Chaudron 2005). Among our study sample, less than 2% of women indicated to have received a medical diagnosis of depression postpartum (not shown). In comparison, some studies have shown that as high as 37% of Hispanic women are affected by PPD compared to 10-15% in the US population (Stapeler 2017). This trend of misdiagnosis or underdiagnosis reveals the level of intervention that needs to occur among ethnic and minority groups.

Participants within our study were more likely to indicate a lack of interest in daily activities than those indicating depressive symptoms. Lack of interest is an indicator of depression; it might also be viewed as a more socially acceptable response among our study population. To our knowledge, there are no other studies that examine the association between hurricane disasters and having a lack of interest in activities postpartum.

Public health implications on hurricane disaster and mental health

Maternal mental health post-disaster impacts a mother's well-being, and more research is needed to adequately address the needs of postpartum women's health in post-disaster environments. Given the cultural context, the self-reported indicator of depression can underrepresent the actual burden of disease within the population. Individuals in our study were

more likely to report having a lack of interest (8%) in daily activities and potentially is a closer representation of the actual burden of disease. Understanding the challenges, public health can better target interventions to minimize stigmas through campaigns and the health care system.

Future non-clinical studies should consider using other indicators of depression as it possibly could yield a more accurate representation of the actual disease occurrence. Indicators like having a lack of interest, feeling of "guilt, sadness, inadequacy, tearfulness, listlessness, sleep disturbances, inability to concentrate, and mood lability" (Martinez-Schallmoser 2003, Sun 2021). Proper assessment of depression can provide public health with a more accurate account of those who are most vulnerable and susceptible to adverse outcomes post-disaster to provide the necessary intervention and care needed to ensure pregnant and postpartum women can live their optimal health.

5.2 Zika Precaution and Hurricane Preparedness in Puerto Rico

The second study suggests that the engagement in Zika precautionary measures is associated with hurricane disaster planning in those receiving professional services and the use of repellent. This could be due to the engagement of WIC in promoting mosquito spray services and Zika prevention kits to pregnant women. This study also found that WIC participants were more likely to engage in disaster planning. The majority of individuals, 65%, reported obtaining professional spray services to treat their property, with 85% of those receiving services being WIC participants (not shown). We speculate this might be due to the increased services offered through WIC to pregnant women at the time to combat the spread of the Zika virus. However, we can only speculate as our data cannot assess the participants who obtained professional spray services provided by WIC clinics.

During the Zika outbreak in Puerto Rico, WIC played a vital role in supplying Zika protective kits and conveying messages to pregnant women. We can speculate that in this context, WIC was a trusted source for information and to assess the potential that WIC can play a broader role when it comes to messaging and supporting pregnant and postpartum women pre- and post-disaster.

Public health implications on preparedness

The current study points to opportunities to explore additional research examining the psychological and potentially synergistic effect of multiple disaster planning and postpartum mental health. With the increased occurrence of infectious diseases and climate crises, the need for research in disaster occurrence has grown tremendously in disaster planning and its impact on mental health outcomes. Consideration should be made for cultural and social norms and potential biases and stigmas as it relates to mental health issues specifically depression among pregnant and postpartum women. While data collection immediately following a disaster is challenging, studies to understand its impact are essential to improve pregnant and postpartum women's health and well-being.

5.3 Study Strengths and Limitations

Overall, both studies are subjected to limitations that should be recognized. First, the study does not represent all postpartum women as it is limited to women who delivered a live birth during the study period in Puerto Rico. Second, data collected are self-reported and are subject to recall bias and respondents might be more likely to provide a socially acceptable response. However, as a cross-sectional study, this study benefited from assessing the association

88

of multiple exposures and outcomes across the same study population in a relatively short time frame post disasters. In addition, the systematic recruitment of participants and high participation and retention help bolster this study.

5.4 Conclusion

This study shows the importance of addressing mental health and disaster preparedness measures among pregnant and postpartum women to address their unique needs. The health of pregnant and postpartum women is essential to public health and our community. While postpartum mental health problems might be underrepresented within our study population, it is necessary to understand the contextual circumstances at play related to depression, the stigmas that exist, and the increased pressure placed on mothers by culture, society, and the women themselves. Furthermore, the synergistic effects of multiple disasters within the population adds another layer of complexity. The opportunity to further take actions to address the potential mental challenge by provide the tools to be prepared to combat disasters of a pandemic nature or climate related. This acknowledgment and understanding will help us to better plan and develop the appropriate interventions to disrupt the burden of disease. So, we can create the right strategies to better serve pregnant and postpartum women residing in different communities and settings with varying cultural norms and beliefs.

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Appendix A: Study 1 Variable Description

Variables	Description
Variables	**Description**

Hurricane Experiences — Respondents were asked 15 hurricane experience related questions: *"I'm going to read a list of things that could happen because of a hurricane or disaster. For each one, please tell me if you experienced it due to the hurricanes."* Questions were categorized into 4 areas: Life threatening events, loss of resources, housing disruption, and challenges in receiving aid.

a. Life-threatening events

    i. Felt unsafe because of the lack of order and security after the disaster

    ii. Felt life was in danger

    iii. Injured or became ill

    iv. Household member was injured or became ill

    v. Someone close to you died in the disaster

    vi. Walked through debris or floodwater

b. Loss of Resources

    i. Without electricity for one week or longer

    ii. Had trouble getting clean drinking water

    iii. Had trouble getting enough food to eat

c. Disruption in Housing

    i. Lived in temporary housing or in conditions that you were not accustomed to

    ii. Had to move to another municipality

    iii. Lost personal belongings

    iv. Separated from loved ones who you feel close to

d. Challenge Receiving Government Aid

    i. Had trouble getting services or aid from the government

    ii. Had trouble dealing with insurance or disaster relief agencies

Appendix B: Pregnancy Risk Assessment Monitoring System- Zika Postpartum Emergency Response 2.0 (PRAMS-ZPER) In Hospital Survey

ZPER 2.0 Maternal_English *1*

The first questions are about you.

1. What is your date of birth?

___ / ___ / ___
MONTH   DAY   YEAR

2. What is the highest level of education that you have completed?

Check one answer

- ❑ Less than high school diploma
- ❑ High school diploma or General Education Diploma (GED)
- ❑ Some college or technical school
- ❑ Completed college
- ❑ Some graduate school
- ❑ Completed graduate school (masters or doctorate degree)

3. How many weeks pregnant were you when you delivered?

___ Weeks

- ❑ I don't know

4. In which municipality do you live now? *(If you live in multiple locations, please write the name of the municipality where you live most of the time.)*

_____
Name of municipality

5. Are you currently married?

- ❑ Yes
- ❑ No

6. What kind of health insurance do you have to pay for your delivery?

Check all that apply

- ❑ I do not have health insurance of any kind
- ❑ Private health insurance from my job or the job of my husband or partner
- ❑ Private health insurance from my parents
- ❑ Private health insurance that I paid for myself or that someone else paid for me
- ❑ Government health insurance/Medicaid (also known as Mi Salud or Reforma)
- ❑ Other health insurance → Please tell us:

_____

The following questions are about Zika virus.

7. During your most recent pregnancy, how worried were you about getting infected with Zika virus?

Check one answer

- ❑ Very worried
- ❑ Somewhat worried
- ❑ Not at all worried

8. During your most recent pregnancy, how worried were you about having a child with microcephaly or another birth defect linked to Zika virus? *(Microcephaly is a birth defect where a baby's head is smaller than expected when compared to babies of the same sex and age.)*

Check one answer

- ❑ Very worried
- ❑ Somewhat worried
- ❑ Not at all worried

9. While you were pregnant, which **ONE** of these sources did you trust the **most** for receiving information about Zika virus?

| Check **one** answer |

- ❏ Healthcare worker (for example, a family doctor, OB/GYN, midwife, other medical professionals)
- ❏ Other pregnant women
- ❏ Family or friends
- ❏ The Centers for Disease Control and Prevention (CDC)
- ❏ The Puerto Rico Department of Health
- ❏ Television or radio news
- ❏ Social network sites like Facebook
- ❏ WIC or the Special Supplemental Nutrition Program for Women, Infants, and Children
- ❏ Websites about pregnancy or other topics ⟶ Please tell us:

- ❏ Some other source ⟶ Please tell us:

10. At any time **during your most recent pregnancy**, did you talk with a doctor, nurse, or other healthcare worker about Zika virus?

| Check **one** answer |

- ❏ Yes, a healthcare worker talked with me without my asking about it
- ❏ Yes, a healthcare worker talked with me, but only **after** I asked about it
- ❏ No ⟶ | Go to Question 16 |

11. Did a doctor, nurse, or other health care worker **offer** you a test for Zika virus at any of the following times? *(For each time period, check **Yes** if you were offered a test then, or **No** if you were not.)*

	Yes	No
a. Before my most recent pregnancy	❏	❏
b. During the 1st trimester	❏	❏
c. During the 2nd trimester	❏	❏
d. During the 3rd trimester	❏	❏

12. Did you **get** tested for Zika virus at any of the following times? *(For each time period, check **Yes** if you were tested then, or **No** if you were not.)*

	Yes	No
a. Before my most recent pregnancy	❏	❏
b. During the 1st trimester	❏	❏
c. During the 2nd trimester	❏	❏
d. During the 3rd trimester	❏	❏

If you did not get tested for Zika virus infection, go to Question 15.

13. Where did you get tested for Zika virus? *(For each time period when you got tested for Zika, check the box for the location where you received the test.)*

Check:
DO if Doctor's Office
HDC if Health Department Clinic
H if Hospital
L if Laboratory, either private or commercial
O if Other Location

	DO	HDC	H	L	O
a. Before my most recent pregnancy	❏	❏	❏	❏	❏
b. During the 1st trimester	❏	❏	❏	❏	❏
c. During the 2nd trimester	❏	❏	❏	❏	❏
d. During the 3rd trimester	❏	❏	❏	❏	❏

14. How long **after being tested** did you receive your Zika test result? *(For each time period when you got tested for Zika, check the box for the amount of time you had to wait to receive the result.)*

Check:
<1M if Less than one month after being tested
1M if One month or more after being tested
HR if Haven't received my test result
DR if I don't remember

	<1M	1M	HR	DR
a. Before my most recent pregnancy	❏	❏	❏	❏
b. During the 1st trimester	❏	❏	❏	❏
c. During the 2nd trimester	❏	❏	❏	❏
d. During the 3rd trimester	❏	❏	❏	❏

15. Did a doctor, nurse, or other health care worker **tell** you that you **had** Zika virus infection at any of the following times? *(For each time period, check Yes if you were told you had Zika virus then, or No if you were not.)*

	Yes	No
a. Before my most recent pregnancy	❏	❏
b. During the 1st trimester	❏	❏
c. During the 2nd trimester	❏	❏
d. During the 3rd trimester	❏	❏

The following questions are about avoiding mosquito bites.

16. **During your most recent pregnancy**, did you do any of the following things to avoid mosquito bites in your home? *(For each one, check Yes if you did it or No if you did not.)*

	Yes	No
a. Always used screens on open doors	❏	❏
b. Always used screens on open windows	❏	❏
c. Always kept unscreened doors and windows closed	❏	❏
d. Always used fans or air conditioning	❏	❏
e. Eliminated standing water from my house and yard **on a weekly basis**	❏	❏
f. Slept under a mosquito bed net	❏	❏
g. Set up mosquito traps	❏	❏

17. **During your most recent pregnancy**, did you receive any of the following professional services for mosquito control? *(For each one, check Yes if you received the service or No if you did not.)*

	Yes	No
a. Indoor spraying of my house for mosquitos	❏	❏
b. Outdoor spraying around my house and in my yard for mosquitos	❏	❏
c. Application of larvicides around the outside of my house	❏	❏

18. **During your most recent pregnancy**, how often did you use a mosquito repellent **on your exposed skin or clothing** when you went outside, even if you were only outside for a short time?

Check **one** answer

- ❏ Always
- ❏ Sometimes
- ❏ Rarely or when I saw mosquitos
- ❏ Never → **Go to Question 20**

19. When you used mosquito repellent on **your exposed skin or clothing**, how many times a day did you apply it?

Check **one** answer

- ❏ More than once a day
- ❏ Once a day

20. When you did **not** wear mosquito repellent during your most recent pregnancy, what were your reasons for not wearing it?

Check **all** that apply

- ❏ I did not like the way it smelled or it made me nauseous
- ❏ I did not like the way it made my skin feel
- ❏ I worried about the chemicals in the repellent harming me
- ❏ I worried about the chemicals in the repellent harming my baby
- ❏ I forgot to apply it
- ❏ I had an allergy or it made my skin itch
- ❏ I didn't think I needed it
- ❏ I was rarely outside
- ❏ Mosquito repellent was too expensive
- ❏ Other reason → Please tell us:

21. **During your most recent pregnancy**, how often did you wear long sleeves and long pants?

Check **one** answer

- ❏ Every day → **Go to Question 23**
- ❏ Most days
- ❏ Some days
- ❏ Never

Go to Question 22

22. When you did **not** wear long sleeves and long pants during your most recent pregnancy, what were your reasons?

Check **all** that apply

- ❑ It was too hot to wear long sleeves or long pants
- ❑ I did not have clothes with long sleeves or long pants
- ❑ My clothes with long sleeves or long pants no longer fit due to pregnancy
- ❑ I was rarely outside
- ❑ Other → Please tell us:

The following questions are about your husband or any male partner.

23. At any time during **your most recent pregnancy**, did you have sex with any male partner?

- ❑ Yes ⟶ Go to Question 25
- ❑ No

24. Why didn't you have sex with a male partner at any time **during your most recent pregnancy?**

Check **one** answer

- ❑ I didn't have a partner → Go to Question 29
- ❑ I was trying to avoid Zika infection
- ❑ I didn't want to have sex → Go to Question 28
- ❑ Some other reason Please tell us:

25. Did you have sex at any time **during your most recent pregnancy** in the:

	Yes	No, to avoid Zika	No, for another reason
a. **First** 3 months	❑	❑	❑
b. **Second** 3 months	❑	❑	❑
c. **Last** 3 months	❑	❑	❑

26. How often did your partner use a condom when you had sex **during your most recent pregnancy** in the:

	Every time	Some times	Never
a. **First** 3 months	❑	❑	❑
b. **Second** 3 months	❑	❑	❑
c. **Last** 3 months	❑	❑	❑

If you used condoms every time you had sex during your most recent pregnancy, go to Question 28. Otherwise, go to Question 27.

27. What were your reasons for not using condoms **every time** when having sex **during your most recent pregnancy?**

Check **all** that apply

- ❑ I didn't know I was pregnant
- ❑ I didn't think I needed to use condoms during pregnancy
- ❑ I didn't think a condom would prevent Zika infection
- ❑ I didn't think Zika was still a problem
- ❑ I didn't think my partner had Zika virus
- ❑ I was not worried about getting the Zika virus
- ❑ I didn't want to use condoms
- ❑ My partner didn't want to use condoms
- ❑ I could not get condoms when I needed them
- ❑ I could not afford condoms
- ❑ I forgot to use condoms
- ❑ My partner or I had an allergy
- ❑ Some other reason ⟶ Please tell us:

28. During your most recent pregnancy, did your husband or any male partner get tested for Zika virus?

- ❑ Yes
- ❑ No
- ❑ I don't know

29. **During your most recent pregnancy,** did a doctor, nurse, or other health care worker tell anyone who lived with you that they were infected with Zika virus? *(For each person, check **Yes** if they were told that they had Zika virus during your pregnancy, or **No** if they were not told.)*

	Yes	No
a. My husband or male partner	❑	❑
b. Another family member	❑	❑
c. Another person who lived with me	❑	❑

The following questions are about the time before your pregnancy.

30. Thinking back to **just before** you got pregnant with your new baby, which **ONE** of the following statements best describes how **you** felt about becoming pregnant?

Check **one** answer

❑ I wanted to be pregnant later, because of the risks associated with Zika virus
❑ I wanted to be pregnant later, because of other reasons
❑ I wanted to be pregnant sooner
❑ I wanted to be pregnant then
❑ I didn't want to be pregnant then or at any time in the future
❑ I wasn't sure what I wanted

31. When you got pregnant, what relationship did you have with your new baby's father?

Check **one** answer

❑ He was my husband (legally married)
❑ He was my partner (not legally married, but a long-term partner)
❑ He was my boyfriend (a casual partner)
❑ Other → Please tell us:

32. Thinking back to **just before** you got pregnant with your new baby, how did **your new baby's father** feel about you becoming pregnant?

Check **one** answer

❑ He wanted me to be pregnant later, because of the risks associated with Zika virus
❑ He wanted me to be pregnant later, because of other reasons
❑ He wanted me to be pregnant sooner
❑ He wanted me to be pregnant then
❑ He didn't want me to be pregnant then or at any time in the future
❑ He wasn't sure what he wanted
❑ I don't know

33. **Before you got pregnant** with your new baby, did a doctor, nurse, or other health care worker talk to you about how to prepare for a healthy pregnancy and baby?

❑ Yes
❑ No

34. **When you got pregnant** with your new baby, were you or your husband or partner doing anything to keep from getting pregnant? Some things people do to keep from getting pregnant include using birth control pills, condoms, withdrawal, or natural family planning.

❑ Yes ⟶ **Go to Question 36**
❑ No
↓
Go to Question 35

117

35. What were your reasons or your husband's or partner's reasons for not doing anything to keep from getting pregnant?

*Check **all** that apply*

- ❑ I didn't mind if I got pregnant
- ❑ I thought I could not get pregnant at that time
- ❑ I had side effects from the birth control method I was using
- ❑ I had problems getting birth control when I needed it
- ❑ I thought my husband or partner or I was sterile (could not get pregnant at all)
- ❑ My husband or partner didn't want to use anything
- ❑ I forgot to use a birth control method
- ❑ Other → Please tell us:

If you or your husband or partner were not doing anything to keep from getting pregnant, go to Question 37.

36. What method of birth control were you using **when you got pregnant**?

*Check **all** that apply*

- ❑ Birth control pills
- ❑ Condoms
- ❑ Contraceptive shots or injections (Depo-Provera°)
- ❑ Contraceptive implant in the arm (Nexplanon° or Implanon°)
- ❑ Contraceptive patch (OrthoEvra°) or vaginal ring (NuvaRing°)
- ❑ IUD (including Mirena°, ParaGard°, Liletta°, or Skyla°)
- ❑ Natural family planning (including rhythm method)
- ❑ Withdrawal (pulling out)
- ❑ Other → Please tell us:

The last questions are about health care you received during your pregnancy and after delivery.

37. How many weeks or months pregnant were you when you had your **first** visit for prenatal care?

[____] Weeks **OR** [____] Months

- ❑ I didn't go for prenatal care → **Go to Question 42**

38. During your most recent pregnancy, did anyone ever go with you to your prenatal care visits?

*Check **one** answer*

- ❑ Yes, my husband or partner
- ❑ Yes, someone else
- ❑ No ⟶ **Go to Question 41**

39. How often did your husband or partner go with you to your prenatal care visits?

*Check **one** answer*

- ❑ Every time
- ❑ Sometimes
- ❑ Only when I was going to have a procedure (such as an ultrasound)
- ❑ Never

40. How often did you try to schedule your prenatal care visits so your husband or partner could attend?

*Check **one** answer*

- ❑ Every time
- ❑ Sometimes
- ❑ Only when I was going to have a procedure (such as an ultrasound)
- ❑ Never

118

41. During any of your **prenatal care visits**, did a doctor, nurse, or other health care worker talk to you about any of the things listed below? *(For each item, check **Yes** if they did or **No** if they did not.)*

	Yes	No
a. How to prevent mosquito bites during pregnancy	❏	❏
b. Using condoms during sex to prevent Zika infection	❏	❏
c. Types of clothes to wear to prevent mosquito bites	❏	❏
d. Using mosquito repellent on my skin or clothing	❏	❏
e. The risk of Zika virus passing to my baby during pregnancy	❏	❏
f. Birth defects associated with Zika virus or Zika Congenital Syndrome	❏	❏

42. Did you start (or will you start) any of the following birth control methods **before leaving the hospital**? *(For each one, check **Yes** if started or will start to use the method before leaving the hospital or **No** if you did not or will not.)*

	Yes	No
a. Tubes tied or blocked (female sterilization)	❏	❏
b. IUD (Mirena*, Skyla*, Liletta*, ParaGard*)	❏	❏
c. Contraceptive implant (Nexplanon*)	❏	❏
d. Contraceptive shot/injection (Depo-Provera*)	❏	❏
e. A prescription method (such as birth control pills, the patch, or ring)	❏	❏

Thank you for answering these questions! Your answers will help us keep pregnant women and their babies healthy.

Appendix C: Pregnancy Risk Assessment Monitoring System- Zika Postpartum

Emergency Response 2.0 (PRAMS-ZPER) Telephone Follow-up Survey

ZPER 2.0 Telephone Follow-up Questionnaire – English phone version

We would like to ask you some questions about your health and experiences since the birth of your recent baby.

1. **Since your new baby was born**, have you had a postpartum checkup for yourself? A postpartum checkup is the regular checkup a woman has about 4 to 6 weeks after she gives birth.

   (Don't read)   1   No
                          2   Yes → **Go to Question 3**
                          8   Refused → **Go to Question 4**
                          9   Don't know/don't remember → **Go to Question 4**

2. I'm going to read a list of reasons why some women may not have a postpartum checkup. For each one, please tell me if it was a reason for you. Would you say that you did not have a postpartum checkup because_____?

| | (Don't read) | | | |
	No (1)	Yes (2)	Refused (8)	Don't know (9)
a. You didn't have health insurance to cover the cost of the visit				
b. You felt fine and did not think you needed to have a visit				
c. You couldn't get an appointment when you wanted one				
d. You didn't have any transportation to get to the clinic or doctor's office				
e. You had too many things going on				
f. You couldn't take time off from work				
g. Road conditions made it unsafe to travel after Hurricanes Irma and Maria				

h.	You weren't able to get enough gasoline or diesel to drive after Hurricanes Irma and Maria				
i.	You were afraid to leave where you were staying after Hurricanes Irma and Maria				
j	Services were not available due to damage to the clinics from the hurricanes				
k.	Did you have some other reason?				
l.	**IF YES, ASK:** What kept you from having a postpartum checkup? _____ _____				

INTERVIEWER: If the respondent did <u>not</u> have a postpartum check-up, go to Question 4.

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3. **During your postpartum checkup,** did your doctor, nurse, or other health care worker **do** any of the following things? I am going to read a list of things. Did they _____?

(**PROBE**: Did a doctor, nurse, or other health care worker _____ during your postpartum checkup?)

Subject	(Don't read)			
	No (1)	Yes (2)	Refused (8)	Don't know (9)
a. Talk to you about clothes to wear to prevent mosquito bites				
b. Talk to you about using mosquito repellent on your skin or clothing				
c. Talk to you about using condoms during sex to prevent Zika infection				
d. Talk to you about birth control methods you can use after giving birth				
e. Give or prescribe you a contraceptive method such as the pill, patch, shot or Depo-Provera®, NuvaRing®, or condoms				
f. Insert an IUD such as Mirena®, ParaGard®, Liletta®, or Skyla® or a contraceptive implant such as Nexplanon® or Implanon®				

4. I'm going to read a list of health conditions. For each one, please tell me if a doctor, nurse or other health care worker told you that you have the condition *since your new baby was born.* Have you been told that you have _____?

(**PROBE:** *Since your new baby was born*, has a doctor, nurse or other health care worker told you that you had _____?)

| | | (Don't read) | | |
	No (1)	Yes (2)	Refused (8)	Don't know (9)
Condition				
a. Diabetes				
b. High blood pressure or hypertension				
c. Depression				
d. Anxiety				
e. Zika virus infection				

5. *Since your new baby was born*, how often have you felt down, depressed, or hopeless? Would you say that it's been always, often, sometimes, rarely, or never?

(Don't read)	1	Always
	2	Often
	3	Sometimes
	4	Rarely
	5	Never

| | 8 | Refused |
| | 9 | Don't know/don't remember |

6. *Since your new baby was born*, how often have you had little interest or little pleasure in doing things you usually enjoyed? Would you say that it's been always, often, sometimes, rarely, or never?

(Don't read)	1	Always
	2	Often
	3	Sometimes
	4	Rarely
	5	Never

7.   ***Since the hurricanes or disaster,*** have you felt that you have needed mental health services such as counseling, medications, or support groups to help with feelings of anxiety, depression, grief, or other issues?

        1   No **Go to Question 9**

        2   Yes

        8   Refused **Go to Question 9**

        9   Don't know/don't remember **Go to Question 9**

8.   Were you able to get the mental health services that you needed?

        1   No

        2   Yes

        8   Refused

        9   Don't know/don't remember

These next questions are about your new baby.

9. Is your baby alive now?

        1   No **Say** *"We are very sorry for your loss."* and **Go to Question 26**

        2   Yes

        8   Refused **Go to Question 26**

        9   Don't know/don't remember **Go to Question 26**

10. Is your baby living with you now?

        1   No **Go to Question 26**

        2   Yes

        8   Refused **Go to Question 26**

        9   Don't know/don't remember **Go to Question 26**

11. Did you ever breastfeed or pump breast milk to feed your new baby, even for a short period of time?

        1   No **Go to Question 14**

        2   Yes

12. Are you currently breastfeeding or feeding pumped milk to your new baby?

	1	No
	2	Yes ☐ **Go to Question 14**
	8	Refused ☐ **Go to Question 14**
	9	Don't know/don't remember ☐ **Go to Question 14**

13. How many weeks or months did you breastfeed or pump milk to feed your baby?
    (**PROBE:**   About how many weeks or months?)

	1	Less than 1 week
	2	Number of weeks_____ (Range: 1-40)
		OR
	3	Number of months _____ (Range: 1-9)
	8	Refused
	9	Don't know/don't remember

14. *In the month after your baby was born*, did you experienced any of the following problems caring for your baby due to the situation caused by the hurricanes? I'm going to read a list of problems. For each one, please tell me if you experienced it. Did you have problems _____?

Problem	No (1)	Yes (2)	Refused (8)	Don't know (9)
a. Getting the medical attention **your baby** needed				
b. Getting medical attention **for yourself**				
c. Feeding your baby				
d. Getting enough money to take care of your baby				
e. Getting clean water to bathe your baby				
f. Providing a safe place for your baby to sleep				
g. Protecting your baby from mosquito-borne infections				
i. Paying your bills				
j. Getting money out of the bank				

15. Has your new baby had any health care visits with a doctor, nurse, or other health care worker since you left the hospital when your baby was born?

       (Don't read)   1   No
                        2   Yes ➔ **Go to Question 17**
                        8   Refused ➔ **Go to Question 18**
                        9   Don't know/don't remember ➔ **Go to Question 18**

16. I'm going to read a list of things that can keep babies from having a health care visit. For each one, please tell me if it applied to you or your new baby.

       (**PROBE:**   Would you say that your baby did not get a health care visit because _____)

Reason	(Don't read)			
	No (1)	Yes (2)	Refused (8)	Don't know (9)
a. You don't have health insurance for your baby				
b. You don't have enough money to pay for the visit				
c. You don't have a way to get your baby to the clinic or doctor's office				
d. You don't have anyone to take care of your other children				
e. You can't get an appointment				
f. You don't think your new baby needs a health care visit				
g. Road conditions made it unsafe to travel after Hurricanes Irma and Maria				
h. You weren't able to get enough gasoline or diesel to drive after Hurricanes Irma and Maria				
i. You were afraid to leave where you were staying after Hurricanes Irma and Maria				
j Services were not available due to damage to the clinics from the hurricanes				
k. Did anything else keep your baby from having a health care visit?				
l. **IF YES, ASK:** What else kept your baby from having a health care visit? _____ _____				

INTERVIEWER: If the baby has <u>never</u> had a health care visit after leaving the hospital, got to Question 18.

17. Please tell me which *one* of the following best describes where you *usually* take your new baby for health care visits? Is it _____?

        (**PROBE:**   Where do you *usually* take your baby for his or her health care visits?)

                  1   A private doctor's office
                  2   A Health Department Clinic such as a IPA Clinic
                  3   A Community Health Center such as a 330 Clinic
                  4   The Regional Pediatric Center
                  5   The Hospital Emergency Room
                  6   A Hospital Outpatient Clinic
                  7   Do you take your baby to some other place?
                       ➔ **IF YES, ASK:**   Where else do you usually take your baby for his or her health care visits? _____

        (Don't read)   8   Refused
                         9   Don't know/don't remember

18. Do you have someone you think of as your baby's personal doctor or nurse? *A personal doctor or nurse is a health professional who knows your baby well and is familiar with your baby's health history. This can be a family doctor, a pediatrician, a specialist doctor, a nurse practitioner, or a physician assistant.*

(**PROBE:** Does your baby have one or more than one person you consider their personal doctor or nurse?)

                  1   No
                  2   Yes, one person
                  3   Yes, more than one person

    (Don't read)   8   Refused
                     9   Don't know/don't remember

19. *Since your new baby was born***,** has a doctor, nurse, or other health care worker talked with you about any of the following things? I am going to read a short list. For each topic, please tell me if they talked to you about it or not.

  (**PROBE:** Did a doctor, nurse, or other health care worker talk to you about _____?)

Topic	No (1)	Yes (2)	Refused (8)	Don't know (9)
			(Don't read)	
a. Dressing your baby in long sleeves and long pants to avoid mosquito bites				
b. Using mosquito repellent on your baby's exposed skin or clothing				
c. Putting a mosquito net over your baby's crib or bed				
d. What the signs and symptoms of Zika virus infection are in a baby				

20. ***Since your new baby was born***, has a doctor, nurse, or other health care worker told you that your new baby was infected with Zika virus during your pregnancy?

   (Don't read)   1   No
   2   Yes

   8   Refused
   9   Don't know/don't remember

21. I'm going to read a list of health conditions. For each one, please tell me if your new baby has the condition. Does your baby have _____?

	Condition	No (1)	Yes (2)	Refused (8)	Don't know (9)
a.	Hearing problems				
b.	Vision problems				
c.	Poor weight gain				
d.	Difficulties feeding				
e.	Smaller than normal head size				
f.	Muscle weakness				
g.	Deformity of the feet				
h.	Convulsions				

INTERVIEWER: If the baby does not have any of the health conditions listed above, go to Question 24.

22. Has your new baby's regular doctor suggested that you take your baby to see a *specialist doctor* for help with his or her health conditions?

(Don't read)   1   No
                      2   Yes
                      8   Refused
                      9   Don't know/don't remember

23. Have you been asked if you would like to talk to other families who have had babies with health conditions similar to those of your new baby?

(Don't read)   1   No
                      2   Yes
                      8   Refused
                      9   Don't know/don't remember

24. I'm going to read a list of services some babies receive. For each one, please tell me if your new baby received the service. Has your new baby received _____ ?

	Services	No (1)	Yes (2)	Refused (8)	Don't know (9)
a.	A scan or ultrasound of his or her head, for example a CT Scan or MRI				
b.	A hearing test				
c.	An eye exam				
d.	An assessment of how your baby is developing				
e.	An evaluation by a specialists for physical therapy				
f.	Assistance from a nutritionist				

25. Would you say that you have someone that you can turn to for day-to-day emotional support with taking care of your new baby?

              2   Yes

              8   Refused

              9   Don't know/don't remember

The next questions are about the use of contraception.

26. **How do you feel about having a child sometime in the future?**
    (**PROBE:** Would you say that _____?)

                  (1)   You do not want to have any more children

                  (2)   You would like to have another child in the next 1-2 years

                  (3)   You would like to have another child in the next 3-5 years

                  (4)   You would like to have another child after 5 or more years

                  (5)   You would like to have another child, but you are not sure when

(8)   Refused

                  (9)   Don't Know / Don't Remember

27. Are you or your husband or partner doing anything ***now*** to keep from getting pregnant? Some things people do to keep from getting pregnant include having their tubes tied, using birth control pills, condoms, withdrawal, or natural family planning.

1   No

              2   Yes ⬛ **Go to Question 29**

              8   Refused ⬛ **Go to Question 30**

              9   Don't know/don't remember ⬛ **Go to Question 30**

28. I'm going to read a list of reasons some women or their husbands or partners have for not doing anything to keep from getting pregnant. For each one, please tell me if it is one of the reasons for you or your husband or partner ***now***. Is it because_____?

    (**PROBE:** You aren't doing anything to keep from getting pregnant ***now*** because_____?)

Reason	⬛⬛⬛⬛⬛⬛			
	No (1)	Yes (2)	Refused (8)	Don't know (9)
a. You want to get pregnant				
b. You are pregnant now				
c. You had your tubes tied or blocked				
d. You don't want to use birth control				

	No (1)	Yes (2)	Refused (8)	Don't know (9)
e. You are worried about side effects from birth control				
f. You are not having sex				
g. Your husband or partner doesn't want to use anything				
h. You have problems paying for birth control				
i. You had problems getting contraception due to the hurricane (doctor office closed, pharmacies closed, etc.)				
j. Is there any other reason you're not doing anything to keep from getting pregnant now?				
k. **IF YES, ASK:** What is the reason you are not doing anything to keep from getting pregnant now? _____ _____				

INTERVIEWER: If the respondent or her husband or partner are <u>not doing</u> anything to keep from getting pregnant *now*, go to Question 30.

INTERVIEWER: If the respondent is pregnant *now*, go to Question 30.

29. I'm going to read a list of birth control methods. For each one, please tell me if you or your husband or partner are using this method ***now***.

(**PROBE:** What are you, your husband, or partner using ***now*** to keep from getting pregnant?)

Method	(Don't read)			
	No (1)	Yes (2)	Refused (8)	Don't know (9)
a. Tubes tied or blocked, female sterilization, or Essure®				
b. Vasectomy or male sterilization				
c. Birth control pills				
d. Condoms				
e. Shots, injections or Depo-Provera®				
f. Contraceptive patch or OrthoEvra® or vaginal ring or NuvaRing®				
g. IUD, including Mirena® or ParaGard®, Liletta®, or Skyla®				

	No (1)	Yes (2)	Refused (8)	Don't know (9)
h. Contraceptive implant in the arm, including Nexplanon® or Implanon®				
i. Natural family planning including rhythm method				
j. Withdrawal or pulling out				
k. Not having sex or abstinence				
l. Are you or your husband or partner using anything else to keep from getting pregnant **now**?				
m. **IF YES, ASK:** What other birth control method are you or your husband or partner using now to keep from getting pregnant? _____ _____ _____				

The following questions are about your experiences during and after Hurricanes Irma and Maria. We understand that the time after the hurricanes could have been difficult. We would appreciate your support answering the following questions since they could help us understand the challenges pregnant women face during and after a disaster.

30. I'm going to read a list of things that could happen because of a hurricane or disaster. For each one, please tell me if you experienced it **due to the hurricanes**? Would you say that _____?

   (**PROBE:** Did you experience any of the following *because of the hurricanes*?)

Experience	No (1)	Yes (2)	Refused (8)	Don't know (9)
		(Don't read)		
a. You felt like your life was in danger when the disaster struck				
b. You were injured or became ill				
c. A member of your household was injured or became ill				
d. You walked through debris or floodwater				
e. You were without electricity for one week or longer				
f. Someone close to you died in the disaster				
g. You were living in temporary housing or in conditions that you were not accustomed to				
h. You lost personal belongings				

i. You were separated from loved ones who you feel close to				
j. You had trouble getting services or aid from the government				
k. You had trouble dealing with insurance or disaster relief agencies				
l. You had trouble getting clean drinking water				
m. You had trouble getting enough food to eat				
n. You felt unsafe because of the lack of order and security after the disaster				
o. You had to move to another municipality				

31. How would you describe any damage to your home from the hurricanes? I'm going to read a list of options. Please tell me which ONE best describes your situation.

1	Your home was not damaged
2	Your home had minor damage, but the living areas were still livable
3	Your home had major damage
4	Your home was destroyed
8	Refused
9	Don't Know

INTERVIEWER: If the mother is younger than 21 years of age, skip Question 32 and Question 33.

32. *Since the hurricanes*, did any of the following people push, hit, slap, kick, choke, or physically hurt you in any other way?

	(Don't read)			
Person	No (1)	Yes (2)	Refused (8)	Don't know (9)
a. Your husband or partner				
b. Your ex-husband or ex-partner				
c. Another family member				
d. Someone else				

33. *Since the hurricanes*, has anyone forced you to have sex or to take part in touching or any sexual activity when you did not want to?

(Don't read)
- 1 No
- 2 Yes
- 8 Refused
- 9   Don't know/Don't remember

34. I'm going to read a list of health services that you may have needed since the hurricanes. For each service, please tell me if you needed the service and if you received the service since the hurricanes. Have you needed _____? Did you receive _____?

   (**PROBE:** Since the hurricanes, have you needed _____? Did you receive them?)

Service	(Don't' Read)					
	Needed		**Received**		Refused	Don't Know
	No (1)	Yes (2)	No (3)	Yes (4)	(8)	(9)
a. Health services for an illness	No	Yes	No	Yes		
b. Health services for a chronic condition	No	Yes	No	Yes		
c. Health services for an injury	No	Yes	No	Yes		
d. Dental health services	No	Yes	No	Yes		
e. Supply of medications	No	Yes	No	Yes		
f. Health services for Zika virus infection	No	Yes	No	Yes		

> **INTERVIEWER: If the mother did NOT need any of the services OR If the mother DID need a service but DID receive it, go to Question 36.**

35. I'm going to read a list of reasons that some people may have for not receiving health services since the hurricanes. For each one, please tell me if it was a reason that you did not receive one or more of the health services you needed since the hurricanes. Was it because_____?

   (**PROBE:** Was a reason you did not receive the health care service you needed since the hurricanes because _____?)

Reason	(Don't read)			
	No (1)	Yes (2)	Refused (8)	Don't know (9)
a. Road conditions made it unsafe to travel				
b. You weren't able to get enough gasoline or diesel to drive				
c. You didn't have enough money or insurance to pay for your visits				
d. You were sick or injured and could not travel				
e. You were afraid to leave where you were staying				
f. You did not know where to go to get the services				
g. Services were not available due to damage to the clinics form the disaster				
h. You couldn't get an appointment when you wanted one				
i. You couldn't take time off from work or school				
j. You had no one to take care of your children or other family members				

k. You had too many other things going on				
l. Some other reason?				
m. If "Yes" ASK: What was the reason? _____ _____ _____				

36.   Among the following means of communication, where did you look **first** for reliable information regarding the hurricanes and cleaning up or recovery efforts after the disaster? I'm going to read a list of means of communication. Was it __?

(**PROBE:** Where did you look **first** for reliable information after the hurricanes? Was it _____?)

1	TV
2	Radio
3	Neighbor or word of mouth
4	Announcements placed in public places
5	Local Newspaper
6	Social media like Facebook
7	Internet ➔ Please specify the site: _____
10	Other ➔ Please tell us: _____

(**Don't read**)   8   Refused
                                9   Don't know

37.   I'm going to read a list of kinds of help people may receive after a hurricane. For each one, please tell me if you or any other member of your household received this type of aid as part of disaster relief efforts. Did you receive _____?

(**PROBE:** Did you or any other member of your household receive _____?)

		(Don't read)		
Kind of help	No (1)	Yes (2)	Refused (8)	Don't know (9)
a. Food				
b. Water				
c. Shelter or a place to stay				
d. Clothing				
e. Medications				
f. Financial assistance				

g.	Transportation services				
h.	Alternate sources of electricity such as flashlights, generators, converters, batteries, solar panels.				

38. I'm going to read a list of things some women **may worry about**. For each one, please tell me if it was something you worried about **after the hurricanes, but while you were still pregnant** with your new baby. Would you say that _____?

(**PROBE:** After the hurricanes, but while you were still pregnant, did you worry about any of the following things?)

	Worries	No (1)	Yes (2)	Refused (8)	Don't know (9)
			(Don't read)		
a.	You worried about your baby's health				
b.	You worried about missing prenatal care appointments				
c.	You worried about not being able to contact your doctor in the event of an emergency				
d.	You worried your regular obstetrician/gynecologist would not be available at the time of your baby's birth				
e.	You worried about reaching the hospital in time for your baby's birth				
f.	You worried you would not be able to give birth where you wanted				
g.	You worried about your health				
h.	You worried about not being able to prevent Zika virus infection during your pregnancy				
i.	You worried about getting an infection from other people around you who were sick				
j.	You worried about getting sick from drinking bad water				
k.	You worried about getting sick from eating bad food				
l.	You worried about getting an infection from mosquitos				

39. Around the **time of your baby's birth**, did any of the following things happen due to the situation caused by the hurricanes? I'm going to read a list of things. For each one, please tell me if it happened to you. Would you say that because of the hurricanes_____?

	Thing	No (1)	Yes (2)	Refused (8)	Don't know (9)
			(Don't read)		

135

a.	You missed one or more prenatal care appointments				
b.	You had to change doctors, for example your obstetrician/gynecologist, because your regular doctor was not available due to the hurricane				
c.	A doctor was not present for the birth of your baby				
d.	You had to deliver your baby in a different hospital than you originally planned				

40. During your **time in the hospital after the birth of your baby**, did you receive any of the following things? I'm going to read a list. For each one, please tell me if you received it in the hospital after your baby was born. Did you receive _____?

		(Don't read)		
Thing	No (1)	Yes (2)	Refused (8)	Don't know (9)
a. Enough drinking water				
b. A place to bathe				
c. Electricity in your hospital room				
d. Enough food				
e. A visit from a lactation specialist				
f. Help learning how to take care of your newborn				

41. I'm going to read a list of kinds of help people might need. For each one, please tell me if you would have that kind of help if you needed it *since the hurricanes*. Would you have _____?

(**PROBE:** Since the hurricanes, would you have _____ if you needed it?)

		(Don't read)		
Kind of help	No (1)	Yes (2)	Refused (8)	Don't know (9)
a. Someone to loan you $50				
b. Someone to help you if you were sick and needed to be in bed				
c. Someone to talk with about your problems				

42. Were you working at a job for pay **at the time of the hurricanes**?

(**PROBE:** At the time of the hurricanes, were you _____?)

	1	Yes, you were employed part time (30 hours or less)
	2	Yes, you were employed full time (More than 30 hours)
	3	Not employed ➔ **Go to Question 45**

(Don't read) | 8 | Refused ➔ **Go to Question 45** |
| | 9 | Don't know/don't remember ➔ **Go to Question 45** |

43. Was your job or employment affected by the hurricane?

	1	Yes
	2	No ➔ **Go to Question 45**
	3	No, I didn't have a job before the hurricane ➔ **Go to Question 45**

(Don't read)
| | 8 | Refused ➔ **Go to Question 45** |
| | 9 | Don't know/don't remember ➔ **Go to Question 45** |

44. I'm going to read a list of things that may have happened with the job that you had before the hurricanes. For each one, please tell me if it happened to you. Would you say _____?

| | | (Don't read) | | |
Situations	No (1)	Yes (2)	Refused (8)	Don't know (9)
a. You could not return to work for more than a week because of the hurricanes				
b. You were forced to take vacation or leave				
c. Your company closed or shut down				
d. Your hours were reduced because of the hurricanes				
e. You had to work extra hours or overtime after the hurricanes because other workers were out				
f. Your pay was delayed because of the hurricanes				
g. You lost your job because of the hurricanes				
h. You quit your job				

45. I'm going to read a list of people that might provide additional economic support such as money, food, or basic supplies and necessities to your household aside from yourself. For each one, please tell me if they provided additional economic support to your household before the hurricanes.

(**PROBE**: Aside from you, **before the hurricanes**, who provided additional economic support to your household?)

Persons	(Don't read)

	No (1)	Yes (2)	Refused (8)	Don't know (9)
a. Your husband, partner or baby's father				
b. Your parents				
c. Another family member				
d. Someone else				
e. If "Yes" ASK: Who? _____ _____				

46. Was the job or employment of anyone who contributed to your household affected by the hurricanes?

        1   Yes, one person
        2   Yes, more than one person
        2   No ➔ **Go to Question 49**

(Don't read)   8   Refused ➔ **Go to Question 49**
               9   Don't know/don't remember ➔ **Go to Question 49**

47.   I'm going to read a list of things that may have happened to someone's job after a disaster. For each thing, please tell me if it happened to one or more of the people who contributed money or economic support to your household besides yourself. ~~someone who contributed~~ . Would you say _____?

		(Don't read)		
Situations	No (1)	Yes (2)	Refused (8)	Don't know (9)
a. They could not return to work for more than a week because of the hurricanes				
b. They were forced to take vacation or leave				
c. The company closed or shut down				
d. Their hours were reduced because of the hurricane				
e. They had to work extra hours or overtime after the hurricane because other workers were out				
f. Their pay was delayed because of the hurricane				
g. They lost their job because of the hurricane				
h. They quit their job				

48.   Did you request Disaster Unemployment Assistance? *Disaster Unemployment Assistance is special assistance provided by the government to people who lost their jobs due to a natural disaster.*

    (Don't read)   1   No

2   Yes
         8   Refused
         9   Don't know/don't remember

49. I am going to read you a list of things that some people do to prepare for a disaster. For each one, please tell me if it was something you had done **before** the Hurricanes Irma and Maria to prepare for a disaster. Would you say that _____?

		(Don't read)			
	Things	No (1)	Yes (2)	Refused (8)	Don't know (9)
a.	You had an emergency meeting place for family members other than your home				
b.	Your family and you had practiced what to do in case of a disaster				
c.	You had a plan for how your family and you would keep in touch if you were separated				
d.	You had an evacuation plan if you needed to leave your home or community				
e.	You had an evacuation plan for your child or children in case of a disaster, for example permission for day care or school to release your child to another adult				
f.	You had copies of important documents like birth certificates and insurance policies in a safe place outside your home				
g.	You had emergency supplies in your home for your family, such as enough extra water, food, and medicine to last for at least three days				
h.	You had emergency supplies prepared that you kept in your car, at work, or at home to take with you if you needed to leave quickly				

50. In appreciation for participating in this survey, we would like to give you a small gift. Can you please tell me what address we should send it to?

_____
_____
_____
_____
_____
_____

This finishes the interview. Is there anything you would like to say about your experiences around the time of your pregnancy or the health of mothers and babies in Puerto Rico?

INTERVIEWER: Record respondents verbatim comments below.

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Thanks for answering our questions. Your answers will help us work to keep Puerto Rico mothers and babies healthy. Goodbye.

INTERVIEWER:			
Fill in today's date:	_____ / _____ / 20____ Month Day Year	Time: _____ AM / PM	