

1-2020

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Recommended Citation

Kyne, Dean, et al. "Empirical Evaluation of Disaster Preparedness for Hurricanes in the Rio Grande Valley." *Progress in Disaster Science*, vol. 5, Jan. 2020, p. 100061. ScienceDirect, doi:10.1016/j.pdisas.2019.100061.

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Regular article

Empirical evaluation of disaster preparedness for hurricanes in the Rio Grande Valley

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ARTICLE INFO

Article history:

Received 31 May 2019

Received in revised form 3 December 2019

Accepted 3 December 2019

Available online 13 December 2019

Keywords:

Disaster preparedness

Rio Grande Valley

Evacuation

Emergency planning

Disaster plan

ABSTRACT

Individual emergency preparedness is critical to mitigate and minimize the negative impacts from disasters. Preparing for future disasters could enhance capacity to better cope with the external shocks and achieve a faster return to normalcy after the disaster event. This study investigates how individuals living in the Rio Grande Valley prepare themselves for the future hurricane disasters. The study investigates the state of objective and subjective preparedness and any discrepancy between the two types of disaster preparedness. Using collected data from 590 respondents via an online survey instrument, the study examines the relationships between the states of individual preparedness and selected twelve socio-demographic variables. Findings show that there is a small percent of the total respondents who are actual prepared for disasters. The study concludes with a list of recommendations in order to encourage individuals to better prepare themselves with an aim of enhancing hurricane disaster resiliency in the valley.

1. Introduction

One underlying assumption of the disaster preparedness concept is that our society lives with disasters as a part of our modern-day life, and thus members of the society must take measures to prepare in order to effectively cope with the negative consequences of disasters [1]. There is no commonly agreed-upon definition of disaster preparedness [2], it could be defined as “Preparedness...seeks to improve the abilities of agencies and individuals to respond to the consequences of a disaster event once the disaster event has occurred ([54]; p.102).” Thus, the preparedness focuses on increasing the ability to respond to the consequences of a disaster event whereas mitigation attempts to eliminate or reduce risks associated with an anticipated disaster.

The disaster preparedness is vital at both the organizational and individual levels. There is a common agreement among all key stakeholders that without disaster preparedness, it is hard to achieve the ultimate goal of saving lives and minimizing injuries and damages on properties in managing

disasters. In fact, disaster preparedness requires public participation and persistent efforts to enhance the effectiveness of response and recovery [1].

Preparedness mainly includes activities focused on developing an evacuation plan and securing at least three days' worth of basic necessities (72 h). Similarly, other organizations, including non-profit organizations [3,4], educate individuals to increase their level of disaster preparedness. Studies [5–8] suggest that disaster preparedness includes three common components; (1) basic necessities, such as a three-day supply of water and nonperishable food, a battery-operated radio with working batteries, and a flashlight with working batteries; (2) a written household emergency evacuation plan; and (3) prescription medication supply for at least three days. Preparing for these items only requires individuals to use common sense [9]. Above all, measuring the level of disaster preparedness is essential for organizations that are responsible for preparedness and providing the related education to individuals.

Studies have documented several reasons why individual disaster preparedness is important. The disaster preparedness enhances individual citizens' capabilities to mitigate the negative outcomes effectively and save their lives [10]; it helps individuals increase the skills to cope with disaster events leading to a successful individual disaster response [10,11]; it also helps individuals increase their self-efficacy and optimism leading toward

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minimizing psychological impacts after disaster events [10]; it yields a greater outcome of health and well-being after the disasters [12]; it reduces vulnerability of populations such as elder people who are at risk and vulnerable to disasters [13]; it increase individuals' chances to volunteer and help others during emergencies [6]; it also helps individuals save and prevent families including children and elders from negative impacts from a disaster event [14,15]; and it also helps save lives of pets during a disaster [16–18]. In sum, the benefits of preparing for future disasters observed in the studies mentioned above support the statement that individual disaster preparedness could lead to realizing optimal effectiveness in each of the four phases of disaster management: preparedness, mitigation, response, and recovery. One important notion is that achieving an optimal effectiveness in a phase could influence the likelihood of obtaining optimal effectiveness and success in the following phase. For example, realizing optimal effectiveness in preparedness could increase the likelihood of obtaining optimal effectiveness in each subsequent phase of mitigation. Therefore, the significance and importance of the individual disaster preparedness should not be underestimated, in order to achieve the common goal of saving lives and minimizing negative impacts in the entire disaster management process.

When evaluating disaster preparedness, difference between subjective preparedness and objective preparedness must be taken into consideration. Subjective preparedness refers to a person who thinks he/she is prepared whereas objective preparedness refers to whether he/she has taken measures to prepare, whereas the subjective preparedness refers to a person's feeling toward how well he/she is prepared for a disaster event, whereas the objective preparedness refers to one's preparedness by collecting necessities for the first 72 h after a disaster event. Objective preparedness includes having a disaster plan, a designated safe place, a list of emergency contact numbers, evacuation routes, savings for evacuation expenses, supply of water for three days, supply of food, a battery-operated radio, and a flashlight. However, many practitioners in the emergency and disaster management field evidenced discrepancies between subjective and objective preparedness [19–22]. Researchers (e.g. [1,8,23]) have documented the discrepancies. The actual preparedness and discrepancies vary from one area to another [1]. There are many reasons for unpreparedness: (1) insufficient importance on disaster preparedness, (2) insufficient time to prepare, (3) lack of information on how to prepare [8], (4) insufficient financial resources to prepare [24], and (5) insufficient knowledge and motivation [25]. In fact, the discrepancies are highly influenced by socio-demographic characteristics [10] and their determining effects are worth studying in order to increase disaster preparedness [8].

Disaster preparedness is associated with a wide range of socio-demographic characteristics such as age, marital status, children, and income [10]. First, individuals younger in age recognized the importance of actual disaster preparedness [10,26]. Their counterparts, older individuals, see disaster preparedness as the most influential factor in saving their lives [13,26,27], but studies show that older adults lack disaster preparedness [14]. They are vulnerable in the event of disaster, and older individuals with long-term care need more assistance in disaster preparedness [12,26]. For example, more than half of the people who died in Hurricane Katrina were older than 65 [4].

Second, gender role in disaster preparedness is documented with mixed findings. Men were observed to have a lower perception of risk, (e.g., [10]) whereas women were found less likely to prepare for disasters than their male counterparts [12,28]. Elderly females and those in lower socio-economic classes were especially less prepared for disasters [18,26]; for example, homemakers and unemployed females were less prepared due to less access to information on disaster preparedness [23].

Third, many studies in a systematic literature review show that individuals with higher levels of educational attainment are highly associated with disaster preparedness [26,28]. Women and younger individuals with higher education believe that they are responsible for disaster preparedness [10,26]. Those with lower education are less likely to be prepared for a disaster [12] and educated segments of the population are more likely to

prepare [1,26,28]. Individuals with a college degree were observed to have higher rates of preparedness [24,26,28].

Fourth, studies show that minorities are observed to have lower rates of disaster preparedness [18,23,26]. The main reasons for less disaster preparedness are lack of access to disaster preparedness information and resources [18,23,26,29]. For example, Latino frameworkers show less preparedness for disasters due to lack of access to disaster preparedness information [5].

Fifth, populations with poor health, disabilities, and chronic illnesses are less likely to have three days of supplies in a disaster event than their healthy counterparts [8,30]. Those with chronic diseases are less likely than those without to be prepared or have an evacuation plan [12,25]. Populations with a chronic disease or physical disability are at a greater risk, after a disaster, to suffer negative health effects [13,30].

Sixth, health disparities among many Americans due to inadequate healthcare, disparities in access to care, and quality of care have been a great concern because it has obviously become a barrier to a culture of disaster preparedness [31]. To prepare for future disasters and reduce risk, it is necessary to reduce health disparities [31,32]. However, families who have healthcare access tend to receive advice and information for disaster preparedness education from their trusted primary care providers [15].

Seventh, disaster preparedness at household level received attention from some studies [7,25]. Studies documented that household size, which is measured by the number of household members, associated negatively with the availability of resources for disaster preparedness. A study conducted by the Centers for Disease Control and Prevention (CDC), which analyzed the Behavioral Risk Factor Surveillance System (BRFSS) survey data collected in 14 states during 2006–2010, shows that households with 3 or more members are less prepared than their counterparts with only one member.

Eighth, families with minor children were less likely to be prepared for a disaster [1,15,24]. In addition, families having children with special needs were underprepared for disasters [1,15].

Ninth, individuals who received training for disaster preparedness receive education for disaster preparedness; for example, school district members received training for hurricane preparedness [33]. Organizations generally include hazard awareness, developing disaster plans, mitigation, and business continuity in the staff training [34]. Studies point out that individuals who are employed are more likely to have access to information for disaster preparedness than counterparts who are unemployed or homemakers [23,26].

Tenth, individuals living from paycheck to paycheck do not have the luxury of buying three days of supplies for disaster preparedness [35]. However, households with higher income levels and access to insurance have better awareness of risks, mitigation, and preparedness for disasters [10]. Older people with low financial status are vulnerable during a disaster [13] and those with less wealth are less prepared for disasters [12]. Similarly, older people with higher income with informal social support are better prepared for disasters [4]. Studies pointed out a positive association between higher income and disaster preparedness [4,12,24,28,36]. There is a positive association between income and education which is associated with disaster preparedness behaviors [28].

Eleventh, studies found that individuals who have prior experience with disasters have lower rate of disaster preparedness [10,24]. Individuals with an experience of severe damage in a previous disaster event are highly associated with disaster preparedness [26]. In addition, the prior experience is also associated with perceived greater risks and disaster preparedness [10]. In addition, Latinos with prior disaster experience were observed with preparedness for future disasters [5]. It is noted that the positive association between disaster experience and disaster preparedness is observed in the past three years, but experience longer than three years show a negative association [23].

Twelfth, managing pets during disasters poses several issues during disasters or emergencies [37]. Individuals who own pets need disaster preparedness plans for their pets, and residents with pets are less likely to

evacuate [16]. Many pet owners experienced loss of pets during Hurricane Katrina due to lack of disaster preparedness and evacuation plans [18].

There are a couple of emerging issues the country is facing with regard to individual preparedness. On the one hand, low level individual participation in disaster preparedness has become a commonly shared concern by governments at different levels [19–22]. Studies (e.g. [1,8,23]) show that some individuals who think they are prepared are in fact found unprepared, and in certain cases, did not become better prepared even in the aftermath of a natural disaster [23]. On the other hand, Hurricanes Harvey, Irma, and Maria ended the 2017 hurricane season with a record high in damage costs [38]. Specifically speaking, the three major hurricanes in 2017 cost an estimated \$290 billion which broke the 2005 record of \$211 billion [39]. This new normal requires individuals to revamp disaster preparedness to increase community resiliency. At this juncture, it is imperative to understand the current state of disaster preparedness of individuals. This study empirically investigates the state of disaster preparedness by answering the following four research questions.

- 1) What is the state of individual subjective disaster preparedness in the Rio Grande Valley?
- 2) What is the state of individual objective disaster preparedness in the valley?
- 3) Is there any discrepancy between subjective and objective disaster preparedness in the valley?
- 4) What are the socio-demographic characteristics associated with different states of individual disaster preparedness in the valley?

This study is organized as follows. It begins with the environmental setting of the study area. It is followed by methods and materials. Next, it discusses analysis. Then, the study's findings are presented. Finally, it concludes with a list of recommendations.

2. Environmental setting of the study area

The Rio Grande Valley which consists of four counties: Hidalgo, Cameron, Willacy, and Starr. The valley is located at the southern part of Texas, along the Rio Grande River and shares a border with Mexico. According to the 2010 Census, the county hosts a population of >1.3 million; the majority (about 92%) are Hispanic and Latino with >32% living in poverty [40]. The valley is prone to hurricane disasters and flooding. In the past, it has been hard hit by major hurricanes, including Hurricane Beulah in 1967 and Hurricane Dolly in 2008. On August 25, 2017 Hurricane Harvey, of the highest severity level at a Category 4, narrowly missed the valley, and made landfall 100 miles away near Rockport. [41]. These hurricanes negatively impacted lives, properties, and crops in the valley. Hurricane Dolly caused damages estimated at over \$2 billion [42]. Due to these recurring experiences, residents of the valley know that hurricane disasters are, in fact, a part of their lives and they are vulnerable to the catastrophic consequences. To cope effectively with a hurricane disaster (to achieve the ultimate goal of saving lives and minimizing impact), concerted efforts are necessary by key stakeholders including local, tribe, county, state, and federal governments, non-government organizations (NGOs), media, practitioners, and researchers in managing emergencies and disasters. The process of managing emergency and disaster begins with the preparation stage, which is followed by mitigation, response, and recovery stages. In fact, preparedness helps build resiliency of community to respond to and recover from disaster impacts, and public participation in disaster preparedness is key to successful mitigation in a sustainable way [10,25,43]. Among different key stakeholders involved in emergency and disaster management processes, disaster preparedness is regarded as a responsibility for all stakeholders without exception [44].

According to the United States Public Health Emergency Department (US PHE), it is clearly stated that, "Emergency preparedness is a responsibility that starts with individuals. Then the family. Then the community. Then the state. Then the federal government." [44] At the local level, the City of Edinburg, a local government in the valley, suggests that preparedness is essential to saving lives in the event of a devastating hurricane disaster [45].

The critical importance is placed on the individual disaster preparedness by another similar local government of a larger city, San Antonio, Texas [20]. The Hidalgo County government, one of the four counties located in the valley, emphasizes the crucial role of individuals in responding to emergencies and the equal importance of disaster preparedness by both individuals and governments at the local and county levels [45]. At both state and federal levels, the importance of individual disaster preparedness was also highlighted. Texas Senator Cornyn called for individuals to prepare for a weather disaster event in order to save their lives and their families [9]. Texas Governor Greg Abbott provides an in-depth 204-page guidebook via his website, to encourage individuals to prepare themselves for disasters [46]. In practice, individual disaster preparedness involves common-sense steps to plan for a severe weather event, with a belief that this could result in saving themselves and their families in a disaster [9]. Those common-sense steps include a written hurricane plan and securing necessities, typically guided by federal agencies such as the Federal Emergency Management Agency (FEMA) [33].

3. Methods and materials

To collect the data, we use an online survey instrument consisting of 20 questions. We prepared two questions to measure the state of subjective and objective preparedness based on Module 17: General Preparedness of the Behavioral Risk Factor Surveillance System (BRFSS) Survey 2006 [47] (Appendix). The objective preparedness is measured by nine action statements with three answer choices, namely "yes", "no", or "prefer not to answer." They are (1) I have a written disaster evacuation plan, (2) I have designated a safe place in case of a disaster, (3) I have prepared a list of emergency contact numbers; (4) I have familiarized myself with evacuation routes; (5) I have saved money for evacuation expenses; (6) I have a 3-day supply of water; (7) I have a 3-day supply of food; (8) I have a battery-operated radio; and (9) I have a flashlight. Questions 2, 3, 4, and 5 are newly added to the previous survey of the BRFSS. In our view, all nine of the items listed in the preparation checklist in the survey are essential to be prepared for the first 72 h. To be prepared for the first 72 h after a disaster event takes place, we think that an individual could miss only one out of the entire checklist. With our assumption, if respondent selects "yes" to 8 out of 9 total statements, then the respondent is regarded as objectively prepared. Our assumption is shared by the study by Ablah, Konda, and Kelley [48], which use the BRFSS preparedness questions. Individuals are defined as being "prepared" if they select "yes" to 5 out of 6; being allowed to miss only one actionable preparedness measure. Because there is no universally accepted definition of "preparedness," the combination of these measures is believed to form the definition of preparedness used in this study.

Similarly, subjective preparedness is measured by a question used in the BRFSS survey: "Do you think you have prepared for major disasters? with three answer choices, (1) not prepared at all, (2) somewhat well prepared, (3) well prepared [47] (Appendix). The question asks respondents' feelings about how prepared they are to cope with a future disaster. Similar to objective preparedness criteria, due to the lack of a universally accepted definition of subjective preparedness, the answer of 2 or 3 form the measure of "subjectively prepared". Our assumption was shared by the study conducted by Ablah, Konda, and Kelley [48].

With a snowballing sampling method, 8 graduate students in SOCI 6331 Disasters and Society class and 60 undergraduate students in SOCI 1301 Introduction to Sociology class sent out the online survey link to their selected respondents via either email or mobile text message. Then, the respondents were encouraged to forward the survey link to at least two more respondents, who are either friends or immediate family members/relatives who do not live under the same roof but live in the Rio Grande Valley. The valley hosts a total population of 1.34 million, 861,392 of which are aged 20 or older, according to the data 2017 American Community Survey 5-year estimates by US Census Bureau. Therefore, a sample size of 234 (confidence level of 95% and confidence interval of 4) is required. This snowballing resulted in a total of 1448 samples which include 67% (968) from graduate students and 33% (480) by undergraduate students (Table 1). Out of

Table 1
Breakdown of Snowballing sample and response rate.

		Graduate students	Undergraduate students	Total
[1]	Students in class	8	60	68
	Respondents forwarded by each student	120	7	
[2]	Total respondents forwarded	960	420	1380
	Total sample size [1] + [2]	968	480	1448
	Percent of total sample	67%	33%	100%
	Students		Non-Students	Total
	Respondents	167	370	537
	Response rate	31%	69%	37%

1448 respondents, 537 consist of 167 (31%) students and 370 (69%) non-students completed the survey with a 37% response rate. The data were collected between November 20, 2017, and December 1, 2017. To validate the residency of respondents, their zip codes were matched with the list of 53 zip codes located in the Rio Grande Valley. Among 537 total respondents, there were 11 respondents who identified themselves as under 18 years old and they are excluded from data analysis.

We use STATA version 12 and ArcGIS software to compute statistical analysis and spatial distribution. A paired t-test analysis was used to test the difference between objective and subjective perception and Pearson correlation analysis was employed to check the relationship between the state of disaster preparedness and selected socio-demographic variables. Subjective and objective disaster preparedness are visualized through a mapping analysis using ArcGIS program.

4. Analysis

First, as discussed earlier, the measurement of the state of subjective (think) preparedness yields two results: “think-yes,” a respondent thinks that he/she is prepared and “think-no,” a respondent thinks that he/she is not prepared for future disasters (Fig. 2). Similarly, the measurement of the state of objective (act) finally converted as two results: “act-yes,” a respondent thinks that he/she acts to prepare and “act-no,” a respondent thinks that he/she does not act to prepare for future disasters (Fig. 1). Therefore, when combining the state of both subjective and objective preparedness, a respondent could have a state of disaster preparedness in either of the four possible combinations: (1) “think-yes-act-yes,” a

respondent thinks and acts for disaster preparedness, (2) “think-yes-act-no,” a respondent thinks but does not act for disaster preparedness, (3) “think-no-act-yes,” a respondent does not think, but acts for disaster preparedness, and (4) “think-no-act-no,” a respondent does not think or act for disaster preparedness (Fig. 2).

Second, we examine the spatial distribution of the disaster preparedness using ArcGIS program. Third, we examine any association among socio-demographic variables and disaster preparedness.

5. Results and discussion

5.1. Subjective vs. objective preparedness

We find that 8% (40) of the 526 total respondents were regarded as objectively prepared (act-yes) and the remaining 92% (486) were objectively unprepared (act-no) (Fig. 3.A). A paired t-test analysis was conducted to compare the states of subjective preparedness and objective preparedness of individuals in our sample. Results indicate that there was a significant difference between the states of objective preparedness (M = 0.0760, SD = 0.2653) and subjective preparedness (M = 0.0437, SD = 0.5004); $t = 2.9814, p = .0030$. These findings are in line with other studies [8,24] where discrepancies exist between what individuals feel they are prepared for and what they actually prepare for.

We also found that 51% (258) show subjective preparedness (“think-yes”) and the other 49% (268) show subjective unpreparedness (“think-no”) (Fig. 3.A). When combining both objective preparedness and subjective preparedness, the findings show that 49% (258) out of the total are in the state of “think-no-act-no”, 43% (228) are in “think-yes-act-no”, 8% (40) are in “think-yes-act-yes”, but none of the respondents were in “think-no-act-yes” (Fig. 3.B). In other words, about 49% of them correctly perceive themselves as do-not-prepare for future disasters, while 43% think they prepare but actually they do not act for preparedness. Only 8% of the total respondents correctly think and act for disaster preparedness.

The individual nine action statements by subjective and objective preparedness are presented in Tables A1 and A2 (Appendix A). The respondents who indicated themselves as “not prepared at all” do not have any written disaster evacuation plan (Table A2). Similarly, the respondents who are classified in “think-no-act-no” also do not have any written disaster evacuation plan (Table A1). Respondents in the “think-yes-act-yes” group all have three day’s worth of supply food, a flashlight, a designated safe place in case of disaster, and a list of emergency contact numbers

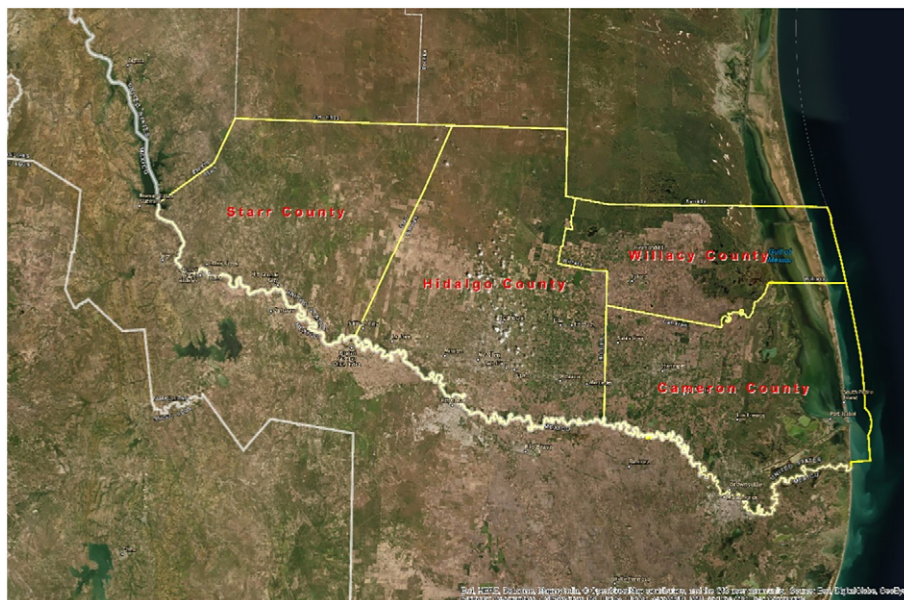


Fig. 1. Study area of Rio Grande Valley in the most southern part of Texas.

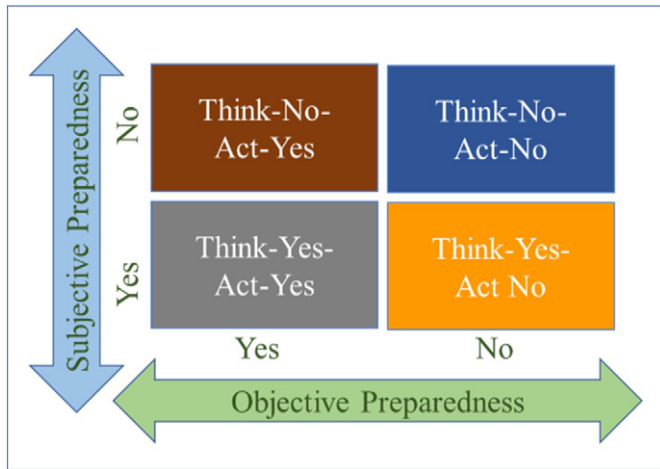


Fig. 2. Four possible combinations of subjective and objective preparedness.

(Table A1). The respondents who indicated “somewhat well prepared” and “well prepared” also indicated the lowest percentages, 14% and 43%, on having a written evacuation plan, respectively.

5.2. Spatial distribution of subjective and objective preparedness

The Rio Grande Valley consists of 53 zip codes in four counties: Hidalgo, Cameron, Willacy, and Starr. First, the percentage of respondents for a given zip code area was computed as the total number of respondents in the given zip code area divided by the total number of respondents in the sample. The spatial distribution of the percentage of respondents by zip code area was visualized in the ArcGIS program map (Fig. 4.A). The sample did not include respondents living in Willacy County. Zip code areas with a higher percentage of respondents were observed in the surrounding cities such as Edinburg, McAllen, Brownsville, and so on (Fig. 4.A). Second, zip code areas with a higher percentage of respondents who think they are subjectively prepared were observed in Cameron County which is adjacent to the seafrent areas (Fig. 4.B). Third, zip code areas with a higher percent of respondents who think they are objectively prepared were scattered in Hidalgo County (Fig. 4.C). Areas with a higher percentage of respondents in the “think-no-act-no” state of preparedness were scattered all over the three counties (Fig. 4.D). Similarly, the higher percentage of respondents in the “think-yes-act-no” category were scattered in Hidalgo and Cameron counties (Fig. 4.E). Surprisingly the zip code areas adjacent to the seafrent contain the highest percentage of respondents. The individuals living in the areas adjacent to the seafrent areas were more prone to hurricane risks than their counterparts living in other places in the valley. However, they lack preparatory action for disasters. The percentage of respondents in the

“think-yes-act-yes” category live mainly in zip code areas surrounding the cities (Fig. 4.F).

5.3. Association with the selected socio-economic variables

In this section, we present the associations between the three states of combined subjective and objective disaster preparedness: “think-no-act-no”, “think-yes-act-no”, and “think-yes-act-yes,” and twelve selected socio-demographic variables.

First, there are 38% of male respondents in “think-no-act-no,” 50% of males in “think-yes-act-no,” and 11% of males in “think-yes-act-yes” (Fig. 4.A). In contrast, there are 54% of female respondents in “think-no-act-no,” 41% of females in “think-yes-act-no,” and 6% of females in “think-yes-act-yes” (Fig. 4.B). A chi-square test of independence was performed to examine the relationship between the state of subjective and objective preparedness and gender. The relationship between these two variables was significant, $X^2(4, N = 526) = 17.74, p < .001$ (Appendix B, Fig. B1). The findings of more than half of the female respondents being in “think-no-act-no” are in line with the findings by Hung [11] that show that males tend to be more prepared for disasters while women tend to be less prepared if they were a decision maker in the household. In general, women are less likely to be prepared for a disaster [12] which is in line with this study’s findings of more than half of the female respondents.

Second, among different racial and ethnic groups, the largest percentage of Blacks (75%) present in “think-no-act-no”, the largest percentage of other (25%) in “think-yes-act-yes”, and the largest percentage of Whites (56%) in “think-yes-act-no” (Fig. 4.B). A chi-square test of independence was performed to examine the relationship between the state of subjective and objective preparedness and race and ethnic groups. The relationship between these variables was significant: $X^2(6, N = 526) = 13.92, p < .030$ (Appendix B, Fig. B2). A similar association was also observed in studies showing Latinos/Hispanics [33] and Blacks [23] who have less preparedness.

Third, among different age groups, we observed the highest percent of individuals in the 18–34 year-old age group (53%) in “think-no-act-no” which was followed by the individuals (45%) in the 18–34 years old age group. We also observed that the largest percentage of individuals in 55–64 year-old age group (56%) were in “think-yes-act-no,” and the largest percentage of individuals in 65 or older group (50%) were in “think-yes-act-no” (Appendix B, Fig. B3). A chi-square test of independence was performed to examine the relationship between the state of subjective and objective preparedness and age groups. The relationship between these variables was significant: $X^2(6, N = 526) = 29.07, p < .000$ (Appendix B, Fig. B3). However, the study findings of individuals who are 65 or older as the highest percentage of who actually prepared for disasters are different from findings of other studies [14] showing older adults having lower level of preparedness. However, it was indirectly supported by

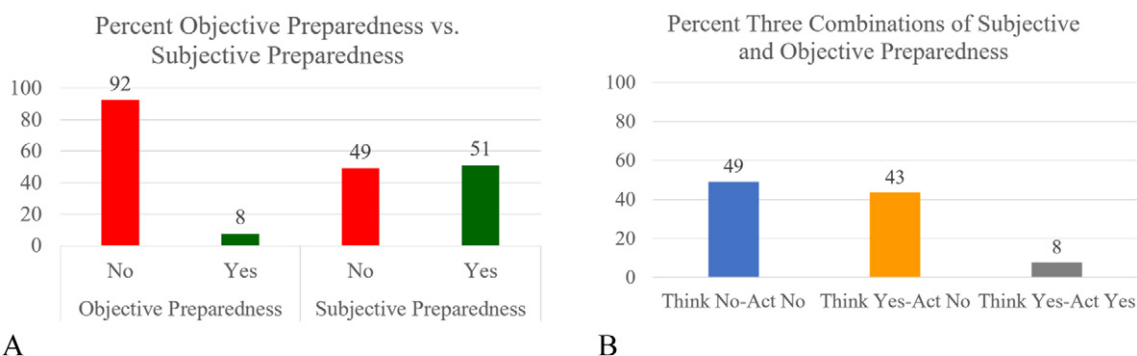
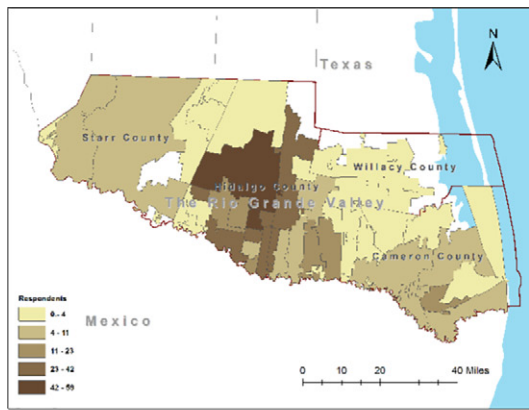
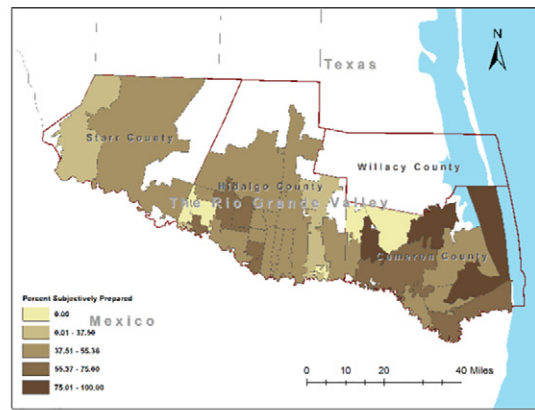


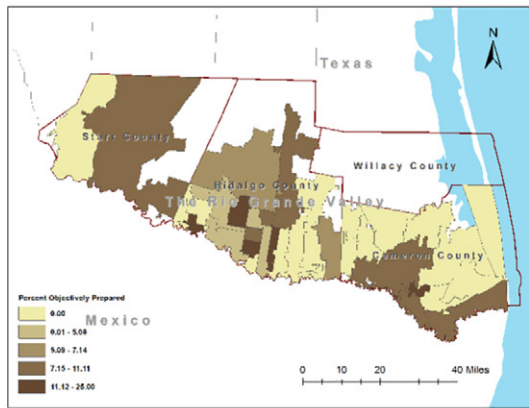
Fig. 3. A Percent objective preparedness versus subjective preparedness B Percent three combinations of objective and subjective preparedness.



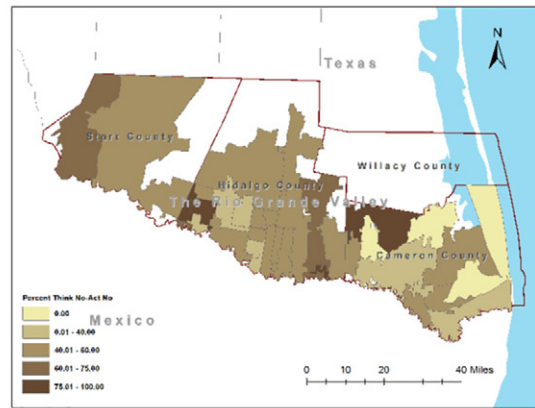
A) Spatial Distribution of Percent Respondents Who Participated in the Study



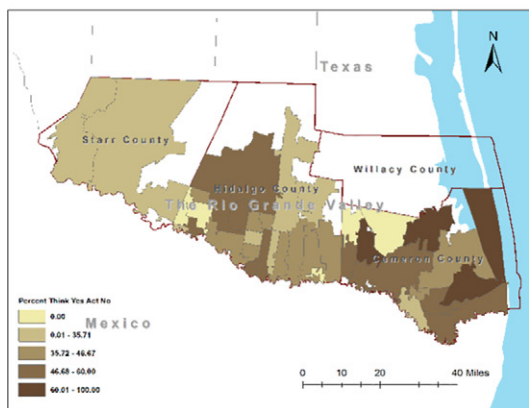
B) Spatial Distribution of Percent Respondents Who Subjectively Prepared



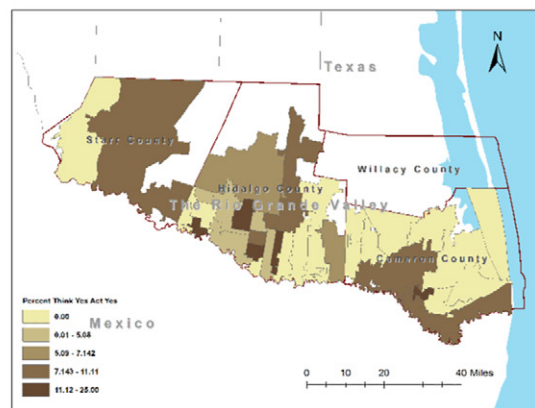
C) Spatial Distribution of Percent Respondents Who Objectively Prepared



D) Spatial Distribution of Percent Respondents Who Think No Preparedness (Think No) with No Action for Preparedness (Act No)



E) Spatial Distribution of Percent Respondents Who Think Prepared (Think Yes) with No Action for Preparedness (Act No)



F) Spatial Distribution of Percent of Respondents Who Think Prepared (Think Yes) with Action for Preparedness (Act Yes)

Fig. 4. A Spatial distribution of percent respondents who participated in the study B Spatial distribution of percent respondents who subjectively prepared C Spatial distribution of percent respondents who objectively prepared D Spatial distribution of percent respondents who think no preparedness (think no) with no action for preparedness (act no) E Spatial distribution of percent respondents who think prepared (think yes) with no action for preparedness (act no) F Spatial distribution of percent of respondents who think prepared (think yes) with action for preparedness (act yes).

findings in studies showing that older adults place more importance on having a stronger will to live [13] and this results in higher level of preparedness in this study.

Fourth, we asked respondents to indicate if they have any medical conditions, including asthma, a disability that requires special equipment, diabetes, cardiovascular disease, have suffered a fall, or are pregnant. If a respondent has at least one of the medical conditions, he/she is labeled as

having a medical condition. Findings indicate that the highest percentage (68%) of respondents who have medical conditions are in “think-no-act-no,” 30% of them in the same group are in “think-yes-act-no,” and 2% of them are in “think-yes-act-yes” (Appendix B, Fig. B4). A chi-square test of independence was performed to examine the relationship between the state of subjective and objective preparedness and medical condition. The relationship between these variables was not significant: $X^2 (2, N =$

526) = 24.32, $p < .000$ (Appendix B, Fig. B4). The study's findings are similar to other study's findings that those with chronic diseases are less likely to prepare themselves for disasters than those without [12,49,50].

Fifth, we asked respondents if they could afford to see a doctor in the past year. Based on the answers to this question, the respondents were placed in two groups: have health care access and do not have health care access. The findings indicate that 67% of the respondents who do not have health care access are in "think-no-act-no," 31% of the respondents who have health care access are in "think-yes-act-no," and 2% of respondents in the same group are in "think-yes-act-yes" (Appendix B, Fig. B5). A chi-square test of independence was performed to examine the relationship between the state of subjective and objective preparedness and healthcare access. The relationship between these variables was significant: $X^2(2, N = 537) = 22.14, p < .000$ (Appendix B, Fig. B5). The significant relationship is supported by another study's findings that individuals with access to health care could receive information for disaster preparedness from their primary health care providers [15].

Sixth, we group the respondents in three groups based on the number of household members they indicated; 1–3 members, 4–6, and 7 or more. We found that 52% of respondents who are in a household with 4–6 members presented in "think-no-act-no, 43% of them are in "think-yes-act-no" and 6% of them are in "think-yes-act-yes" (Appendix B, Fig. B6). A chi-square test of independence was performed to examine the relationship between the state of subjective and objective preparedness and household size. The relationship between these variables was not significant: $X^2(4, N = 526) = 4.67, p < .322$ (Appendix B, Fig. B6). Even though the association was not significant, the study's findings are in line with another study's findings that for individuals with larger household size, it may not be feasible to prepare due to the costs associated with the required resources for preparedness [1,11].

Seventh, we grouped the respondents based on the number of children into four groups; no child, 1–3 children, 4–6 children, and 7 or more children. We observed that 82% of the respondents who have 4–6 children are in "think-no-act-no," whereas 18% of them are in "think-yes-act-no," and 0% of them are in "think-yes-act-yes" (Appendix B, Fig. B7). A chi-square test of independence was performed to examine the relationship between the state of subjective and objective preparedness and age groups. The relation between these variables was significant: $X^2(6, N = 526) = 22.95, p < .001$ (Appendix B, Fig. B7). This study's findings of individuals with 4–6 children showing no preparedness at all are similar to another study's findings that families with children are less likely to prepare for disasters [15,24].

Eighth, we group the respondents in six groups based on the educational attainment: some high school, high school, vocational, bachelor's, graduate (MA/Ph.D.), and others. The findings indicate that 55% of respondents who received some high school education in "think-no-act-no," 43% of them are in "think-yes-act-no," and 3% of them are in "think-yes-act-yes" (Appendix B, Fig. B8). However, 13% of the respondents who received MA/Ph.D. are in "think-yes-act-yes." A chi-square test of independence was performed to examine the relationship between the state of subjective and objective preparedness and educational attainment. The relationship between these variables was significant: $X^2(10, N = 526) = 18.18, p < .052$ (Appendix B, Fig. B8). The significant association was supported by the studies [1,10,12,28].

Ninth, we group the respondents in three groups based on their employment status: employed, unemployed, and unable to work. We found that 52% of respondents who are unemployed are in "think-no-act-no," 40% of them are in "think-yes-act-no," and 7% of them are in "think-yes-act-yes" (Appendix B, Fig. B9). A chi-square test of independence was performed to examine the relationship between the state of subjective and objective preparedness and employment status. The relationship between these variables was not significant: $X^2(4, N = 526) = 2.15, p < .707$ (Appendix B, Fig. B9). Despite the insignificant association, the findings of higher percentage of individuals who are unemployed or unable to work are supported by the findings by the studies [33,34,51].

Tenth, we grouped the respondents based on income into three groups: $< \$25,000$, $\$25,000$ – $\$50,000$, and $> \$50,000$. Findings showed that 52% of the respondents who earn less than $\$25,000$ are in "think-no-act-no," 40% of them are in "think-yes-act-no," and 3% of them are in "think-yes-act-yes" (Appendix B, Fig. B10). In contrast, 18% of the respondents who earned more than $\$50,000$ are in "think-yes-act-yes." A chi-square test of independence was performed to examine the relationship between the state of subjective and objective preparedness and income. The relationship between these variables was significant: $X^2(4, N = 526) = 24.70, p < .000$ (Appendix B, Fig. B10). There are studies that share similar associations [10,12,13,28,36].

Eleventh, we asked the respondents if they had an evacuation experience in the past year. Findings showed that 52% of the respondents who did not have an evacuation experience are observed in "think-no-act-no," 52% of them are in "think-yes-act-no," and 5% of them are in "think-yes-act-yes" (Appendix B, Fig. B11). A chi-square test of independence was performed to examine the relationship between the state of subjective and objective preparedness and evacuation experience. The relationship between these variables was significant: $X^2(2, N = 526) = 38.08, p < .000$ (Appendix B, Fig. B11). This significant positive association is in line with the studies' findings [5,10]. However, it contradicts findings by another study showing a negative association [23].

Twelfth, we also considered the association between pet ownership and preparedness. Findings showed that 47% of respondents who did not own pets in "think-no-act-no," 42% who owned pets in "think-yes-act-no," and 7% of individuals who owned in "think-yes-act-yes" (Appendix B, Fig. B12). A chi-square test of independence was performed to examine the relationship between the state of subjective and objective preparedness and pet ownership. The relationship between these variables was not significant: $X^2(2, N = 526) = 1.626, p < .443$ (Appendix B, Fig. B12). The significant association was supported by the findings by the other studies [16,18].

A summary of findings on associations between state of preparedness and selected socio-demographic characteristics are depicted in Fig. 5. The figure shows the three states of both subjective and objective preparedness and dominant socio-demographics in each of them.

Among 7% of respondents whose state of disaster preparedness is "think-yes-act-yes," the dominant socio-demographic characteristics are those 65 years of age or older: were male, were other race, attained graduate degrees (MA/PhD), had a medical condition, had health care access, lived in a household with 1–3 members, had more than seven children, were employed, earned $> \$50,000$, had an experience of evacuation, and did not own pets.

Among 43% of respondents whose state of disaster preparedness is "think-yes-act-no," the dominant socio-demographic characteristics are those 55–64 years old who are male, are white, completed a high school education, have no medical condition, had healthcare access, lived in a household with 1–6 family members, had no children to 1–3 children, were unable to work, earn between $\$25,000$ and $\$50,000$, had an experience of evacuation, and did not own pets.

Among 59% of respondents whose state of disaster preparedness is "think-no-act-no," the dominant socio-demographic characteristics are those 18–34 years old who are female, are black, completed some high school education, had a medical condition, had no health care access, lived in a household with 7 or more family members, had 4–6 children, were unemployed, earned less than $\$25,000$, did not have an experience of evacuation, and did not own pets. Findings show that the association between the states of disaster preparedness and selected socio-demographic characteristics except household size, employment status, and pet ownership are observed as statistically significant.

6. Conclusion

This study empirically examined the state of individual disaster preparedness in the Rio Grande Valley. The study collected data from 590 respondents on subjective and objective preparedness. First, the findings

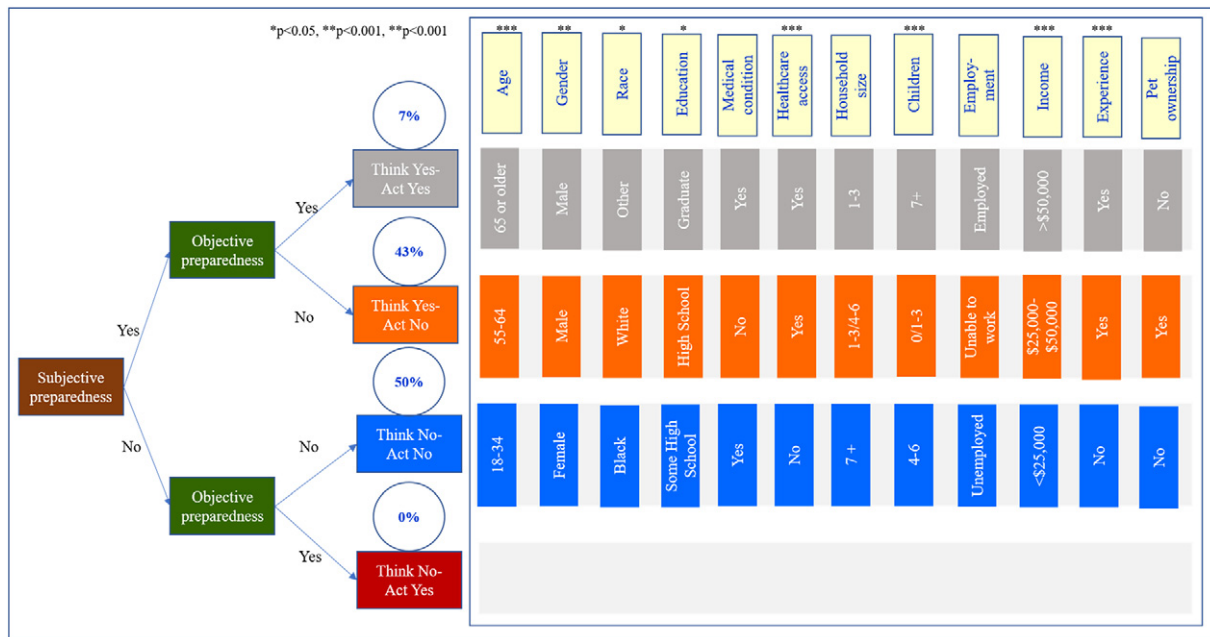


Fig. 5. A Summary of States of Preparedness and Their Relationships with Selected Socio-Demographic Variables.

show that about half (50%) of the total respondents indicated that they did not think to prepare and only about 7% of the total respondents actually take measures to prepare. Among the same respondents, 49% of them indicated that they feel “not prepared at all,” while 47% and 4% of them are somewhat well prepared and well prepared respectively. Second, overall, the study’s findings reveal that majority of respondents lacks the following disaster preparedness items, which include (1) a written disaster evacuation plan, (2) a list of emergency contact numbers, (3) a designated safe place, (4) familiarity with evacuation routes, (5) a battery-operated radio, (6) 3-day of water supply and (7) savings for evacuation expenses. Third, the study’s findings contribute to current knowledge of disaster preparedness by enhancing an understanding of association between the socio-demographic variables and disaster preparedness in these geographical areas. The findings show that these individuals are male, aged between 18 and 34, have medical conditions, lack healthcare access, have sizeable households, have many children, have low educational attainment, have low income, low evacuation expenses, and have pets. In conclusion, “building community resilience requires that the needs of the most vulnerable members of the community be carefully considered (p. S208, [52]).” Therefore, to build a disaster-resilient Rio Grande Valley, it is vital to carefully consider those who with low disaster preparedness and educate and encourage them to prepare for disasters.

6.1. Recommendations

Based on the findings, we would like to provide recommendations to increase individual disaster preparedness. First, providing disaster preparedness education is essential to provide necessary information to prepare for a disaster. Public education programs are desirable for a few reasons: they are effective in educating elders [13]; they significantly increase disaster preparedness among individuals who participate in the program [8]; and it refreshes memories of those who previously participated [23]. Second, the education program should target vulnerable groups which mainly include low-income, uninsured, or under-insured participants [8] and the timing of the educational program happen before any disaster event taking place [53]. Third, as the study’s findings suggest, the education program should emphasize how-to knowledge and skills on formulating an evacuation plan, preparing a list of emergency contact numbers, designating a safe

place, understanding evacuation routes, purchasing/obtaining a battery-operated radio, collecting a 3-day water supply, and savings for evacuation expenses.

6.2. Limitations

There are some limitations in this study. First, this study only measures the disaster preparedness of the first 72 h after a disaster event takes place. Therefore, this study does not address the individual disaster preparedness for long-term recovery. Second, objective preparedness was measured with a 9-item checklist wherein our judgement of 8 out of 9 qualified for objective preparedness. Therefore, findings could vary depending on the items included in the checklist as well as the threshold set for qualifying disaster preparedness status. Third, this study took advantage of technology advancements and utilized an online survey tool. However, this data collection method precluded individuals who do not have access to internet or a smart phone. In addition, the study utilizes a convenience sampling technique which could result in sampling bias.

CRediT authorship contribution statement

Dean Kyne: Conceptualization, Methodology, Data curation, Formal analysis, Investigation, Writing - original draft, Writing - review & editing, Visualization, Supervision, Project administration. **Leslie Cisneros:** Investigation, Data curation, Validation, Writing - original draft. **Josue Delacruz:** Investigation, Data curation, Validation, Writing - original draft. **Bianca Lopez:** Investigation, Data curation, Validation, Writing - original draft. **Cristina Madrid:** Investigation, Data curation, Validation, Writing - original draft. **Rebecca Moran:** Investigation, Data curation, Validation, Writing - original draft. **Alma Provencio:** Investigation, Data curation, Validation, Writing - original draft. **Felix Ramos:** Investigation, Data curation, Validation, Writing - original draft. **Maria Fernanda Silva:** Investigation, Data curation, Validation, Writing - original draft.

Declaration of competing interest

Authors claimed that there is no conflict of interest.

Appendix A

Table A1

Disaster preparedness items by think-act types.

		Think No-Act No	Think Yes-Act No	Think Yes-Act Yes	All Respondents
1	I have written disaster evacuation plan	0	11	53	20
2	I have 3-day of supply of water	24	57	93	62
3	I have 3-day of supply of food	35	71	100	71
4	I have a battery-operated radio	21	46	95	48
5	I have a flashlight	79	93	100	93
6	I have designated a safe place in case of a disaster	17	52	100	52
7	I have prepared a list of emergency contact numbers	30	64	100	64
8	I have familiarized evacuation routes	23	57	98	58
9	I have saved some money for evacuation expenses	14	46	95	48

Table A2

Disaster preparedness items by subjective preparedness.

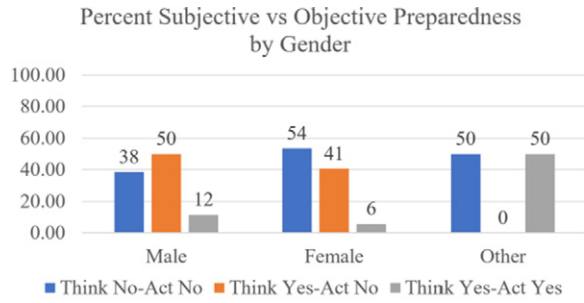
		Not prepared at all	Somewhat well prepared	Well prepared	All Respondents
1	I have written disaster evacuation plan	0	14	43	9
2	I have 3-day of supply of water	24	60	83	44
3	I have 3-day of supply of food	36	74	87	56
4	I have a battery-operated radio	21	49	96	37
5	I have a flashlight	80	94	100	87
6	I have designated a safe place in case of a disaster	17	57	87	39
7	I have prepared a list of emergency contact numbers	30	67	87	50
8	I have familiarized evacuation routes	23	60	96	44
9	I have saved some money for evacuation expenses	14	51	78	34

Table A3

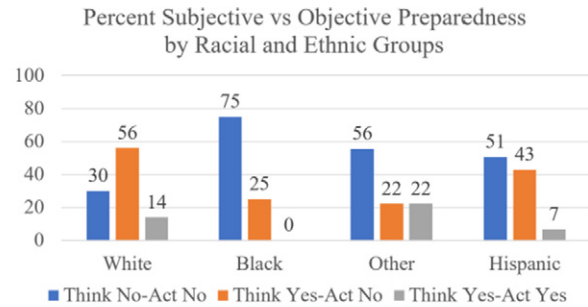
Disaster preparedness items by objective preparedness.

		Objectively Not Prepared	Objectively Prepared	All Respondents
1	I have written disaster evacuation plan	5	53	9
2	I have 3-day of supply of water	40	93	44
3	I have 3-day of supply of food	52	100	56
4	I have a battery-operated radio	32	95	37
5	I have a flashlight	86	100	87
6	I have designated a safe place in case of a disaster	34	100	39
7	I have prepared a list of emergency contact numbers	46	100	50
8	I have familiarized evacuation routes	39	98	44
9	I have saved some money for evacuation expenses	29	95	34

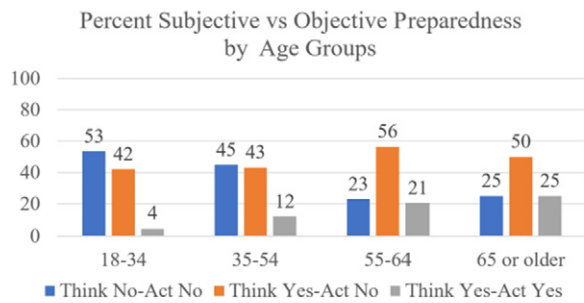
Appendix B



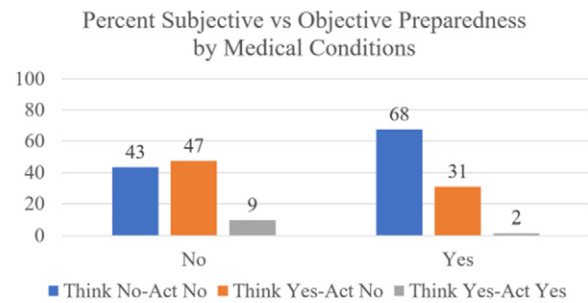
Pearson $\chi^2=17.74$ Pr=0.001 (**)
 Figure B1 Percent Subjective versus Objective Preparedness by Gender



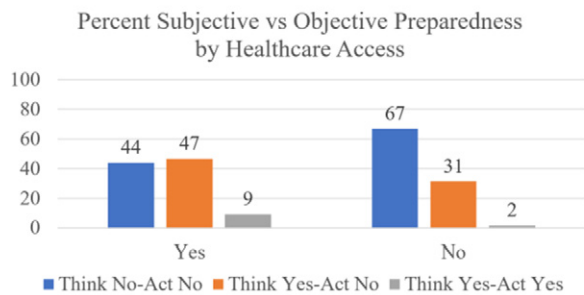
Pearson $\chi^2=13.92$ Pr=0.030 (**)
 Figure B2 Percent Subjective versus Objective Preparedness by Gender



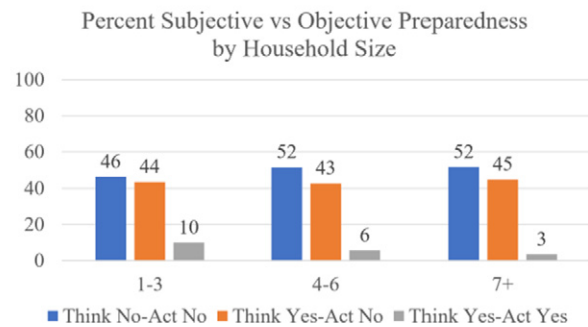
Pearson $\chi^2=29.07$ Pr=0.000 (***)
 Figure B3 Percent Subjective versus Objective Preparedness by Age Groups



Pearson $\chi^2=24.32$ Pr=0.000
 Figure B4 Percent Subjective versus Objective Preparedness by Medical Conditions

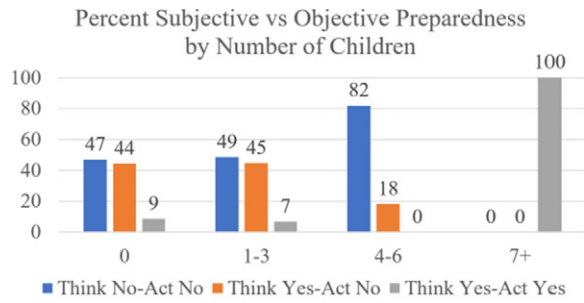


Pearson $\chi^2=22.14$ Pr=0.000 (***)
 Figure B5 Percent Subjective versus Objective Preparedness by Healthcare Access

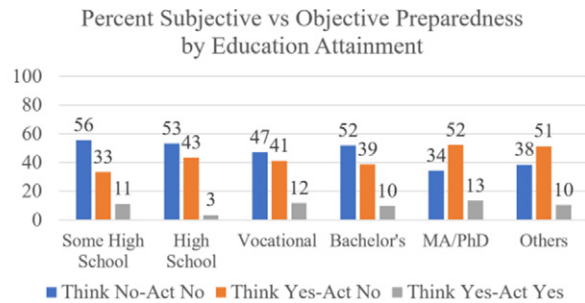


Pearson $\chi^2=4.67$ Pr=0.322
 Figure B6 Percent Subjective versus Objective Preparedness by Household Size

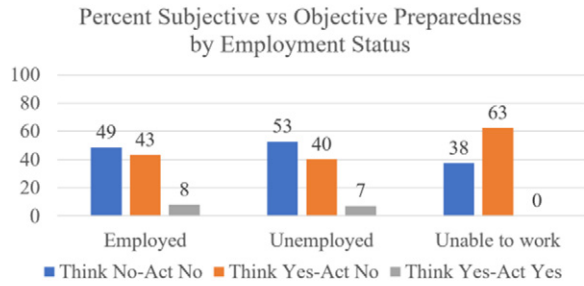
Note: *p<0.05, **p<0.01, ***p<0.001



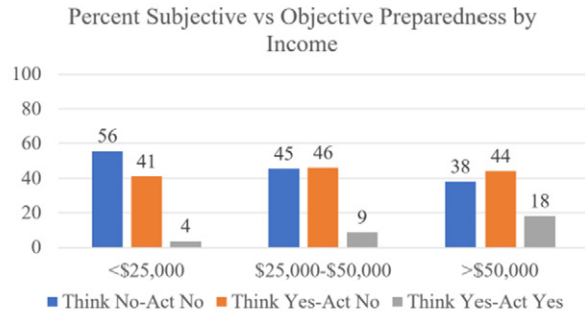
Pearson $\chi^2=22.95$ Pr=0.001 (***)
 Figure B7 Percent Subjective versus Objective Preparedness by Number of Children



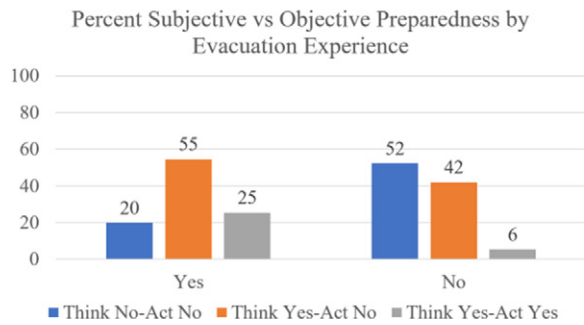
Pearson $\chi^2=18.18$ Pr=0.052 (*)
 Figure B8 Percent Subjective versus Objective Preparedness by Education Attainment



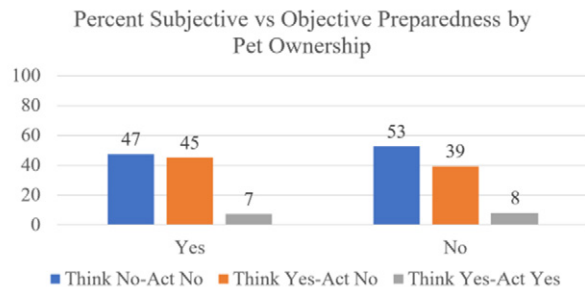
Pearson $\chi^2=2.15$ Pr=0.707
 Figure B9 Percent Subjective versus Objective Preparedness by Employment Status



Pearson $\chi^2=24.70$ Pr=0.000 (***)
 Figure B10 Percent Subjective versus Objective Preparedness by Income



Pearson $\chi^2=38.08$ Pr=0.000 (***)
 Figure B11 Percent Subjective versus Objective Preparedness by Evacuation Experience



Pearson $\chi^2=1.626$ Pr=0.443
 Figure B12 Percent Subjective versus Objective Preparedness by Pet Ownership

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix C

Q1. Please provide your answer to the ALL following statements in regard to your disaster preparedness

		Yes	No	I prefer not to answer
1	I have written disaster evacuation plan *	0	0	0
2	I have designated a safe place in case of a disaster	0	0	0
3	I have prepared a list of emergency contact numbers	0	0	0
4	I have familiarized evacuation routes	0	0	0
5	I have saved some money for evacuation expenses	0	0	0
6	I have 3-day of supply of water *	0	0	0
7	I have 3-day of supply of food *	0	0	0
8	I have a battery-operated radio *	0	0	0
9	I have a flashlight *	0	0	0

Q2. Do you think you have prepared for major disasters? *

- Not prepared at all.
- Somewhat well prepared.
- Well prepared.

Notes: * refers to questions originally included in the Behavioral Risk Factor Surveillance System (BRFSS) survey instrument. The other questions were created by this study.

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