Comparing Severe Weather Communication, Awareness, and Response between non-Hispanic and Hispanic Communities

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ABSTRACT

Studies have shown that Hispanic communities who speak Spanish as their primary language are more vulnerable to severe weather hazards due to inequities, such as language and cultural background barriers. Such studies include examining relevant severe weather events, such as tornadoes in Hispanic territory, to search for common themes related to vulnerability. A few gaps still exist on which techniques to best use for effective communication, such as choice of wording to define a severe weather watch or warning. To examine severe weather awareness and response between Hispanic and non-Hispanic communities, a mixed methods approach will be used in a nationwide survey, in English and Spanish versions. The collected data will then be transferred into a statistical analysis in a computer application. Three survey questions will be examined: the understanding of severe weather watches and warnings, the reliability of weather information resources, and the level of agreement to the response of issued warnings. Combining both surveys, Hispanic immigrants exhibited lower understanding and less response to issued warnings, especially those who are foreign-born. The Hispanic population is projected to continue growing, for which efforts must be done to focus on the cultural diversity within the group. Analysis of evolving technology will be relevant for future studies to provide efficient and effective communication.

1. Introduction

The techniques of effective communication of environmental disaster are important for all communities worldwide. The global population has an annual increase, and ethnic communities have proven to be an important portion, especially those coming from Hispanic origin (Maldonado et al. 2016). With immigration rates increasing, more cities in the United States are becoming more culturally diverse (Ogie et al. 2018). Every citizen in these communities come with different backgrounds, thus leading to effective

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communication throughout the various stages of a disaster becoming a challenge. However, the resources available for emergency preparedness, protective action protocols, and recovery assistance are mostly available in English, which creates inequities (Trujillo-Falcón et al. 2021).

Conflict concerning around ethnic communities' response to emergency situations, such as natural hazards, is often recurring. A number of studies have been made on specific severe weather events focusing on Hispanics' preparedness, interpretation, and response, dating all the way back to 1970. In the 1970 EF4 tornado event in Lubbock County, Texas, it was confirmed that one-half of the deaths came from Spanish households (U.S. Department of Commerce 1970). Hispanic communities often have trouble interpreting severe weather events and their perception of risk is generally higher than non-Hispanics (Adeola 2007; Maldonado et al. 2016). Several studies draw to the same conclusion that Hispanic immigrants are under a more vulnerable position than non-Hispanics or U.S. born Hispanics (Fothergill et al. 1999; Adeola 2007; Carter-Pokras et al. 2007; Benavides 2013; Maldonado et al. 2016). However, gaps are still being discovered relating to the dialect of certain Spanish words and other techniques of disaster preparedness and weather risk communication (Trujillo-Falcón et al. 2021).

The purpose of this study is to extend on innovative techniques to provide information to Hispanic communities before, during, and after a disaster event. To analyze the gaps within previous studies, two research questions would have to be addressed: 1) How would the techniques developed previously and currently in development support Hispanic communities? 2) In what ways would citizens' interpretation of watches and warnings affect the types of resources for severe weather information? To find ways to provide consistent information, a review in the literature for previous studies will be acknowledged as well as an extension of a nationwide survey analysis.

2. Literature Review

The typical stages of a disaster include: perception of risk, behavioral planning, communication of warnings, impacts, response, and recovery (Fothergill et al. 1999). Hispanics go through these stages in different ways than non-Hispanics would, with interpretation and level of trust causing barriers between them (Fothergill et al. 1999; Maldonado et al. 2016). Risk perception and preparedness, communication of protective protocols, and response and recovery in the aftermath are important stages to identify key concepts from previous studies to reduce social vulnerability.

2.1 Risk Perception and Preparedness

The first stage is for communities to make time to prepare for a disaster at appropriate times. According to Fothergill et al. (1999), the preparedness stage is the "pre-event activities in advance to a specific warning." Preparation before a disaster is important for the purpose of ensuring the safety of civilians, which strictly implies that immigrant groups would require resources that explains proper tips of severe weather preparation. However, multiple studies have proven that there are limited resources of risk preparedness available in the Spanish-language (Carter-Pokras et al. 2007; Benavides 2013; Yong et al. 2017; Ogie et al. 2018).

Other factors that can be included in low preparedness are the type of infrastructure families live in and emergency kits they have on hand. A study done by Walter Peacock on hurricanes in Florida emphasizes that Spanish-speaking immigrants and people of color have lower usage of hurricane shutters when it makes landfall (Peacock 2003). Another relevant study is the event of the Whittier-Narrows earthquake, where officials paid the government to send out information on disaster planning, but it was only broadcasted in English (Fothergill et al. 1999). Hispanics are less likely to plan for emergencies and have a high increase in risk, strictly due to the lack of information given out compared to non-Hispanics.

Perception of risk is defined as the process of initial thoughts from individuals on the outcome of incoming disaster (Carter-Pokras et al. 2007; Maldonado et al. 2016). Risk perception is critically important because the concerns on disaster for Hispanics will differ from non-Hispanic whites based on cultural background (Carter-Pokras et al. 2007) and their location of their "social structure" (Adeola 2007). Hispanics who are foreign-born will have prior experience of certain disasters more than other types (Fothergill et al. 1999; Carter-Pokras et al. 2007; Maldonado et al. 2016; Yong et al. 2017). These groups would be defined as being a part of a disaster subculture (Gaviria Pabon 2022), groups of citizens who all share the same cultural characteristics. One example is if a group of foreign-born immigrants came from Mexico, they are bound to have more knowledge about earthquakes than in other groups (Fothergill et al. 1999).

The term "white male effect" is referred to in several studies, which defines as ethnic minority groups, along with women, tend to worry more about

disaster more than whites and males (Adeola 2007; Maldonado et al. 2016). Other types of hazards outside of environmental, such as health, economic, and technological can also affect risk interpretation. An example is that whites have lower reception on specific technologies because of their ability to create while ethnic groups have a higher perception for becoming unknown to the product (Adeola 2007). While Hispanics go through preparing for an event, it ties in with barriers they must overcome, with the major one being language.

2.2 Communication and Protective Protocols

Information that warns communities of incoming disaster is critical for the purpose of their response to them (Fothergill et al. 1999). Hispanics ingest these warnings in certain ways, some that give an advantage and some that cause setbacks. What makes communities rely on certain resources more than others is the amount of trust they have for the institutions that relay them. For instance, for most Hispanics, they do not show a full trust in government emergency agencies and would rely more on family and relatives for disaster communication (Maldonado et al. 2016). In addition, they will rely more on television and radio broadcasts on certain Spanish-speaking programs, such as Univision. Relevant events include the Lubbock County, Texas EF4 tornado (U.S. Department of Commerce 1970) and the Saragosa Texas tornado in 1987 (Aguirre 1988). A setback within these programs during these events is, they did not have the intention of broadcasting warnings to their audience for the reasons that they were used for entertainment (Aguirre 1988).

Another common issue is the timing of warnings during the disaster. A relevant event is the San Diego County Fire of 2003 (Benavides 2013), a wide fire that burned more than 280,000 acres and caused 15 fatalities. Approximately 25% of the population were Latino, so communication efforts would have to make an effect for the group. However, government officials failed to translate vital information to Spanish at a proper time, not leading Latinos in the right direction (Benavides 2013). Government authorities as well as Spanish language media were criticized for not issuing warnings and not keeping up with the English language news (Benavides 2013).

The choice of disaster terminology is another aspect, as Hispanics interpret specific words in different ways. For example, misinterpretations exist when defining severe weather "watch" and "warning", as some emergency agencies use words apart from others. While the National Weather Service (NWS) translates "watch" to *vigiliancia* and "warning" as *aviso*, the Federal Emergency Management Agency (FEMA) translates "watch" with the same word but have "warning" to *advertencia* (Trujillo-Falcón et al. 2022). With inconsistent translations, each word may give a different context, thus recommending different responses among Hispanic Spanish-speakers (Trujillo-Falcón et al. 2021). Similar results happened during the Lubbock County and Saragosa tornadoes, with warnings being broadcasted but Hispanics do not fully understand what they are hearing (U.S. Department of Commerce 1970; Aguirre 1988).

Self-protection of Hispanics becomes critical after communication, especially when it comes to certain warning systems. An example are outdoor sirens, which some Hispanics do not interpret the way they should. Hispanics could not determine the sound the sirens are trying to portray, and only believe that the sound is a source for "taking shelter" (U.S. Department of Commerce 1970). Even if the sirens in the area are doing a test run, they still believe that disaster is on the verge and are taking protective protocols even if the day is clear. Having a language barrier within severe weather warnings is a challenge during a disaster, and finding resources in the aftermath is just as difficult.

2.3 Response and Recovery

The response and recovery stage come in the aftermath of a disaster, where agencies and organizations send out important information on what resources are available (Fothergill et al. 1999). The issue that is proposed for Hispanics is solely the fact that they do not have access to most recovery resources for a variety of factors. Language is an important barrier because when they are searching for recovery options, any information that is posted to billboards is mainly in English (Fothergill et al. 1999). The financial well-being along with personal socioeconomic status are also barriers, with many Hispanics who are foreign-born are denied access for assistance (Carter-Pokras et al. 2007; Maldonado et al. 2016), as well as not having enough finances to pay for insurance on their property (Maldonado et al. 2016). For some, they would rely more on social gatherings in neighborhoods for recovery more than government agencies (Maldonado et al. 2016; Ogie et al. 2018).

The immigration status of Hispanics is critical to point out, for some Hispanics have concern over government officials with being a reliable source of information (Carter-Pokras et al 2007). Thus, it translates to not being able to take part in assistance programs run by the government (Maldonado et al. 2016). Foreign-born Hispanics are more likely denied access to post disaster assistance for not having legal

documents to become a U.S. citizen (Maldonado et al. 2016). Compared with non-Hispanic whites and U.S. born Hispanics, foreign-born Hispanics would more likely have disaster assistance from their families more than government authorities, emphasizing the lack of trust within these programs (Maldonado et al. 2016).

In the aftermath of most disasters, the public believes that the government is responsible for providing relief (Yong et al. 2017), such as having hospitals ready and making certain resources available (Carter-Pokras et al. 2007). Relocation of living in another property is common, as it happened during the Lubbock tornado event (U.S. Department of Commerce 1970; Fothergill et al. 1999). Along with those of Hispanic origin, immigrants (especially undocumented immigrants) will commonly avoid signing any recovery forms when their property is damaged for not owning legal documents, and their status will make them more likely for deportation (Carter-Pokras et al. 2007). With all of the studies done in this social science field between Hispanic and non-Hispanics through the phases of disasters, some gaps still remain. Some gaps include new recovery ways, what dialect should be used, and if preparation remains the same or has a different aspect. To identify these gaps, both a qualitative and quantitative approach will be used for an analysis.

3. Data and Methods

3.1 Participants

The data for this analysis will be the 2022 edition of the Severe Weather and Society Survey in English (WxSurvey) and Spanish (WxEncuesta) (Bitterman et al. 2022). The WxSurvey is an annual nationwide survey that takes the measure of forecasts, warning response, and comprehension of severe weather (Bitterman et al. 2022). This will be the sixth version of the survey in English (see Silva et al. 2017, 2018, 2019; Krocak et al. 2020, 2021), and the second version to be in Spanish (see Bitterman et al. 2021). The English version of the survey took place from July 15 to July 22, 2022, while the Spanish version took place from July 15 to August 5, 2022.

Both surveys use an online questionnaire that was completed by 1,409 English and 633 Spanish participants that are aged 18 years and older. Participants from both surveys were recruited from an Internet panel research company, Qualtrics, that matches their demographic characteristics of the U.S. population using a sampling process (Silva et al. 2017, 2018, 2019; Krocak et al. 2020, 2021; Bitterman 2021; Trujillo-Falcón et al. 2022).

While both surveys share the same types of questions, the WxEncuesta survey has different standards on completion. Respondents have to indicate that they speak Spanish "well" or "very well" to participate. The sample for both surveys have representatives that match the demographic characteristics for a target population by sending invitations. The percentages of the sample from both surveys are based on gender, age, ethnicity, and race (Table 1 for WxSurvey and Table 2 for WxEncuesta). Socioeconomic factors are also considered, such as income, education, and what type of home they live in. More information on survey questions and techniques can be found from the authors listed previously.

Tables 1 and 2: Demographic representativeness of WxSurvey (Table 1) and WxEncuesta (Table 2), with percentages taken from the U.S. adult population in comparison to percentages of participants (Bitterman et al. 2022)

	U.S. Adult Population* (%)	Participants (%)
Gender		
Female	50.9	51.8
Male	49.1	48.2
Age		
18 to 24	11.7	11.4
25 to 34	17.6	19.3
35 to 44	16.8	17.8
45 to 54	15.8	16.3
55 to 64	16.6	14.9
65 and up	21.6	20.3
Ethnicity		
Hispanic	83.0	83.0
Non-Hispanic	17.0	17.0
Race		
White	77.4	78.3
Black or African American	13.1	14.6
Asian	6.1	3.3
Other Race	3.4	3.8
NWS Region		
Eastern	31.7	32.2
Southern	27.3	27.8
Central	20.5	21.7
Western	20.5	18.3

*Population estimates were obtained from the U.S. Census Annual Estimates of the Resident Population by Sex, Age, Race, and Hispanic Origin for the United States and States: April 1, 2020 to July 1, 2021 (PEPASR6H).

	U.S. Adult Population* (%)	Participants (%)
Gender		
Female	51.3	54.7
Male	48.7	45.3
Age		
18 to 24	12.0	17.7
25 to 34	18.0	27.2
35 to 44	16.3	21.0
45 to 54	16.4	14.7
55 to 64	16.7	10.9
65 and up	20.6	8.5
English-speaking		
Yes	92.0	95.1
No	8.0	4.9
Ethnicity		
Non-Hispanic	6.0	1.6
Mexican, Mexican Am., Chicano	55.0	44.2
Puerto Rican	8.0	13.4
Cuban	5.0	7.1
Other Hispanic, Latino, Or Spanish Origin	27.0	33.7
NWS Region		
Eastern	31.6	27.5
Southern	27.1	30.8
Central	20.7	14.1
Western	20.6	27.7

*Population estimates were obtained from the U.S. Census Annual Estimates of the Resident Population by Sex, Age, Race, and Hispanic Origin for the United States and States: April 1, 2020 to July 1, 2021 (PEPASR6H).

3.2 SPSS Statistical Analysis

Both surveys consist of approximately 150 questions that take participants a median time of 20 to 25 minutes to complete. Questions were designed to establish how the U.S. English and Spanish speakers receive, understand, and respond to severe weather forecasts and warnings under the current NWS system (Bitterman et al. 2022; Krocak et al. 2022). Other types of variables are added mostly in the Spanish survey, such as measurements of public trust in the NWS, extreme weather risk perception, and risk literacy. With the survey being translated courtesy of bilingual researchers and meteorologists (Trujillo-Falcón et al. 2022) and prior to its distribution to participants, the survey questions were approved by the University of Oklahoma Institutional Review Board (OU IRB 9418).

Certain variables have been worked with involving specific questions, such as the dialect definitions of watches and warnings towards Spanish speakers (Trujillo-Falcón et al. 2022). For specificity, the variables that will be analyzed for this study will be the understanding of watch and warning definitions (Q1), the reliability of weather information resources (Q2), and in various scenarios of responding to a tornado warning (Q3) (Table 3). The data collected from both surveys start out individually with all questions being used in a CSV file. The data from non-Hispanics and Hispanics will be merged together connected to the survey questions of interest into a separate file to work with. Participants for both surveys were asked to rate the questions in forms of agreement or amount of usage on a 1-5 Likert scale, with 1 generally being lowest and 5 being highest.

A computer application will be used for the statistics collected called the Statistical Package for Social Sciences (SPSS). SPSS is used for statistical analysis, such as data output and chi-square tests. The types of analyses performed within the application include cross-tabulation, comparison of means, and the creation of bar charts. Using the aforementioned questions, the percentages within the Likert scale of agreement or usage will be used for comparing non-Hispanics to Hispanics. The variables will be combined using percentage and mean values from both surveys, and within those values, create bar charts for comparison within Microsoft Excel.

Table 3: Survey questions of interest from the WxSurey and WxEncuesta (Bitterman et al. 2022; Krocak et al. 2022).

Questions	English (WxSurvey	Spanish (WxEncuesta)
Watch and warning (Q1)	In general, do you understand the difference between a severe weather watch and warning?	En general, ¿usted entiende la diferencia entre [vigilancias | amenazas] y [los avisos | las alertas] de condiciones del tiempo severas?
Source reliability (Q2)	How much do you, personally, rely on each of the following sources of information about extreme weather?	Personalmente, ¿cuánto depende de cada una de estas fuentes para obtener información sobre el tiempo extremo?
Response to tornado warnings (Q3)	Please tell us how strongly you agree with the following statements about tornado warnings. If never received, please tell us how you think you will respond.	Por favor díganos qué tan confiado está usted con las siguientes afirmaciones sobre [los AVISOS | las ALERTAS] de tornado. Si alguna vez ha recibido [un AVISO | una ALERTA] de tornado, por favor díganos cómo cree que respondería si recibe [un AVISO | una ALERTA].

4. Results

Beginning with the first question of severe weather interpretation, dialect of wording between English and Spanish speakers have been acknowledged by Trujillo-Falcon et al. (2022), with the use of SPSS expanding on the concept for non-Hispanic and Hispanic respondents. About 47% of the non-Hispanic respondents say that they definitely understand the difference between a tornado watch and warning, while only 36% of Hispanic respondents were able to (Fig 1). About 38% of Hispanic respondents say they probably know the difference. In addition, 19% of Hispanics say they are unsure of the definition if either one is issued.

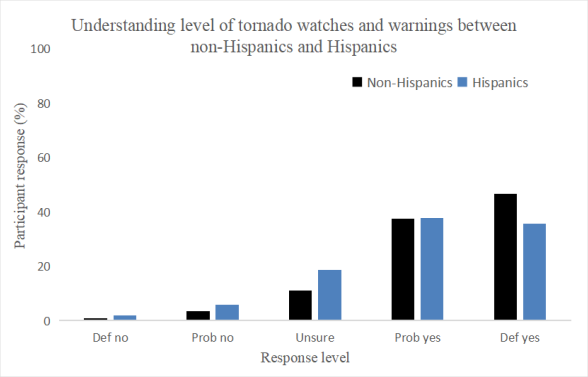

Fig 1: The understanding of tornado watch and warning definitions between non-Hispanic and Hispanic respondents.

Another aspect of the first question is the knowledge of issued watches and warnings, whether non-Hispanics and Hispanics are able to know their definitions. While about 36% of non-Hispanic respondents were able to correctly identify a tornado watch, only about 21% of Hispanic respondents were able to (Fig 2). About 20% of Hispanic respondents mistaken a watch for a warning, with choice of wording being a major reason (Trujillo-Falcón et al. 2022). This is about 10% more than the non-Hispanic respondents that suggested a tornado warning definition (11%). Hispanic respondents also tend to not know the answer to the definition of a watch compared to non-Hispanics (6.1% to 2.5%).

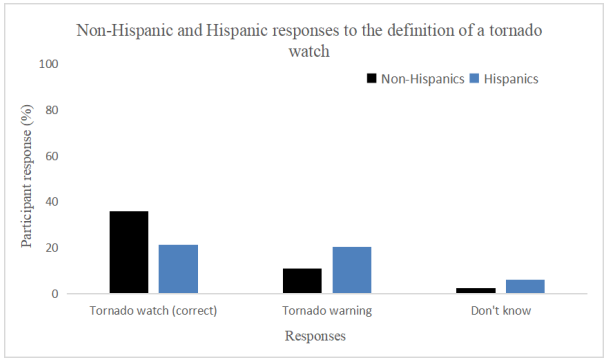

Fig 2: Interpretation of a tornado watch towards non-Hispanic and Hispanic respondents.

The same trend happens for the interpretation of a tornado warning between the respondents. About 40% of non-Hispanics have a higher knowledge towards the tornado warning definition, while about 34% of Hispanic respondents were able to (Fig 3). Mistaking a tornado warning for a watch also happens with the issue of dialect, with 12% for Hispanics compared to 8% of non-Hispanics. Similar to watch interpretation, Hispanic respondents tend to not know the definition of a warning (5%) compared to non-Hispanics (2%).

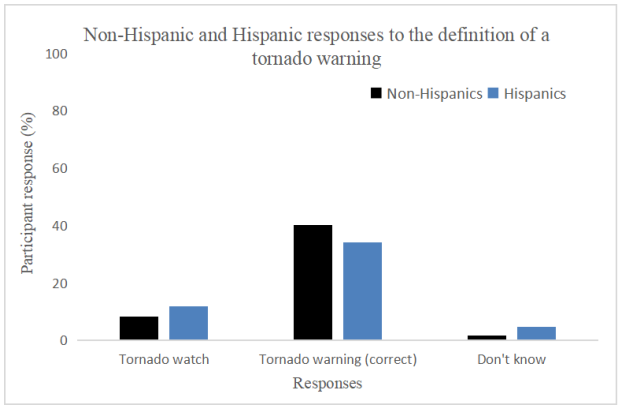

Fig 3: Interpretation of a tornado warning towards non-Hispanic and Hispanic respondents.

The second question of interest is the amount of trust and agreement of which weather information sources are the most reliable towards both communities. The sources that the respondents have to answer are from the following: broadcast radio, weather radio, television programs, Internet websites, social media, word of mouth from the public, text messages, and outdoor warning sirens. Raw counts of responses are converted into mean values based on level of usage. Within this comparison of means, non-Hispanics tend to rely more on weather radios, television programs,

and text messages for severe weather information, having a mean value range from 3.50 to 3.75 (Fig 4). Hispanic respondents also tend to rely on television programs and text messages within the same range. Another source to point out specifically for Hispanic respondents is the high reliability of using outdoor warning sirens more than non-Hispanics (3.70 to 3.50).

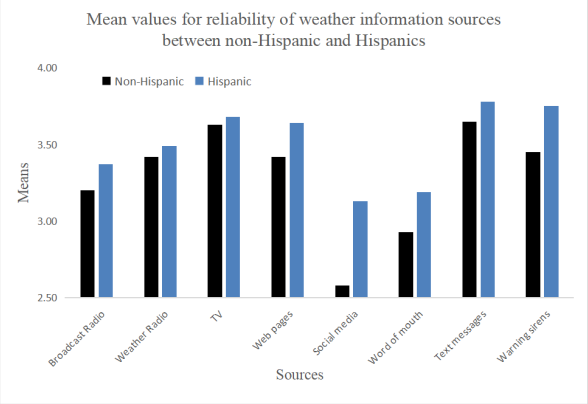

Fig 4: Mean value ranges for weather information source reliability between non-Hispanic and Hispanic respondents.

The third question of interest is the level of agreement to response on statements involving issued tornado warnings, also utilizing comparison of mean values. A lower mean value implies that respondents tend to have lower agreement to scenarios and vice versa for a higher mean value. Between non-Hispanic and Hispanics, both have a high agreement level of the uncertainty of timing of when a warning is issued from beginning to end (2.8 to 3.0) (Fig 5). The level of uncertainty tends to lean more towards Hispanics in all scenarios with higher mean values, specifically for not knowing if a warning is for their area or another one (2.80) and not knowing what actions to take (2.75).

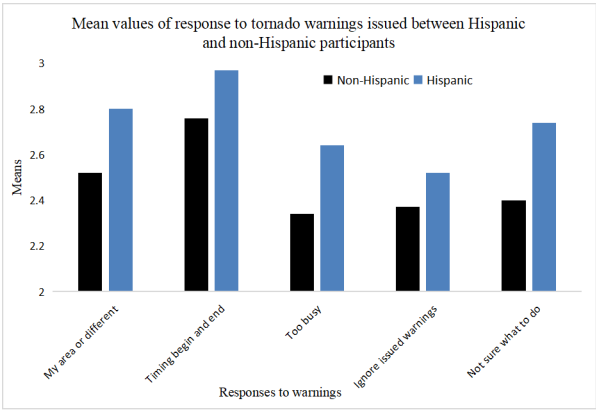

Fig 5: Mean value ranges for agreement levels for issued tornado warnings between non-Hispanic and Hispanic respondents.

Another aspect to the response of issued warnings is which region the participants reside from based on NWS standards. The regions that are included are the Central Region, Eastern Region, Southern Region, and Western Region of the United States. Combined with the communities' data, respondents from all regions have high agreement on the uncertainty of timing, having a mean value range from 2.70 to 2.85 (Fig 6). Respondents from the Southern, Western, and Eastern Regions have higher values in all scenarios compared with the Central Region. Western Region respondents also have high agreement on not knowing what actions to take during an issued warning, with a mean value of about 2.80.

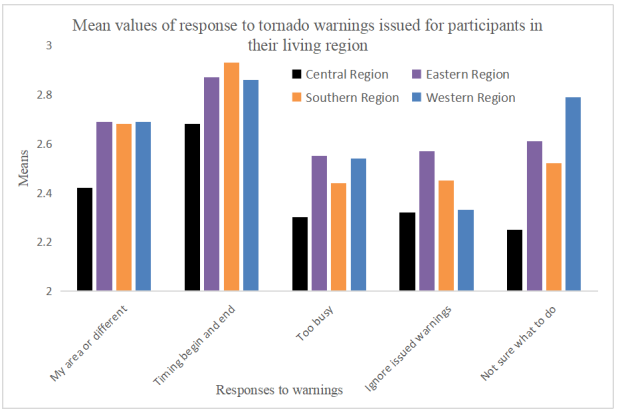

Fig 6: Mean value ranges for agreement levels of issued warnings based on living NWS region.

5. Discussion

The understanding and response to severe weather situations between non-Hispanic and Hispanic communities have consistent themes throughout all of

the research done. One important recurring theme is the sole fact that Hispanics, whether foreign-born or U.S. born (Maldonado et al. 2016), would need to have more knowledge to prepare and take action in regards to emergency situations (Carter-Pokras et al. 2007). The importance of effective techniques for communication of severe weather leads to confusion in the Hispanic community because of misinterpretation and lack of response time. This study seeks to expand on which techniques are appropriate to use to have them feel more equal.

Comparing both communities surrounding the survey questions, non-Hispanics tend to have a higher level of knowledge, awareness, and response to severe weather situations than Hispanics. Connecting with previous research done using last year's survey, the choice of wording used to describe a watch and warning causes confusion (Trujillo-Falcón et al. 2022). The ratio of Hispanics responding that they know the difference compared to those who do not, it may be implied that the portion of the respondents are born in the United States. A study done by Maldonado et al. (2016) indicates that those with Hispanic origin that are U.S. born may have higher knowledge of severe weather hazards and lower inequities (Yong et al. 2017) compared to their foreign-born counterparts. However, even if they are U.S.-born, they still lack knowledge on certain aspects, such as they do not know what protective actions to take against an unfamiliar hazard (Maldonado et al. 2016).

Hispanic communities tend to rely more on programs that have Spanish speaking options, such as certain television programs, text messages, and communication with family (U.S. Department of Commerce 1970; Aguirre 1988). Development to ensure risk communication comes first within these programs to help support future findings within the collected data. The level of response to warnings and their residing area is important to analyze because how one responds to a tornado warning in one region will be different if issued in another (Fothergill et al. 1999; Carter-Pokras et al. 2006; Adeola 2007). Participants from the Southern, Eastern, and Western region have higher agreement of uncertainty compared to the Central Region because issued tornado warnings are not usually common. Some states that are within the Central Region include Texas, Oklahoma, Arkansas, Kansas, and Nebraska, which is where Tornado Alley is located. This supports that participants from the Central Region have higher knowledge on what to do for an issued warning based on prior knowledge (U.S. Department of Commerce; Aguirre 1988).

Hispanics will have to continue to gain more knowledge about preparedness for severe weather when in the case of a warning for their lower status compared to non-Hispanics (Maldonado et al. 2016). Communication efforts to a diverse group is an ongoing process, with brand new techniques and programs in development to accommodate their needs. Emergency agencies will need to take into account the Hispanics' perception of concern, since a significant portion claim that immigration also is called an "emergency" (Carter-Pokras et al. 2007). Those who do not have the legal right to ask for disaster assistance in the aftermath are those who have the lowest amount of awareness (Carter-Pokras et al. 2007; Maldonado et al. 2016). Federal government programs will have to continue to reach out for the diverse group to have necessities and offer insurance for their property (Maldonado et al. 2016). Connected with other studies, this study emphasizes the need for Hispanic communities to know about ongoing disasters, and future work on programs and techniques will be a necessary asset.

6. Conclusion and Future Work

The Hispanic population will continue to keep growing, which will lead to an increase in U.S. diversity. Emergency agencies and forecasters will have to focus their attention on the cultural diversity within this group to provide effective severe weather information when in times of danger. With being an ongoing process, there are still techniques and skills that have not been recorded, such as technological advancements. Creating new machine learning methods, such as the progression of Artificial Intelligence (Ogie et al. 2018), they can be an asset for cohesive translation. Future studies will need to analyze this technology, which will lead to the development of recommended techniques for communication efforts. If done, the development can also pass on with analysis on other types of weather hazards, such as winter weather or tropical storms. With efforts on Hispanic communities' knowledge in severe weather, emergency agencies can develop better practices that will serve best for these underserved communities.

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