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# Technology, Society & Severe Weather Events: Developing Integrated Warning Systems


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This work was supported by the Engineering Research Centers (ERC) Program of the National Science Foundation under NSF Cooperative Agreement No. EEC-0313747. Any opinions, findings and conclusions, or recommendations expressed in this material are those of the authors and do not necessarily reflect those of the National Science Foundation.


University of Massachusetts Amherst | University of Oklahoma | Colorado State University | University of Puerto Rico Mayaguez | Disaster Research Center


CASA is primarily supported by the Engineering Research Centers Program of the National Science Foundation under NSF award number 0313747.

# Engineering Research Center (ERC) for Collaborative Adaptive Sensing of the Atmosphere (CASA)

- “Revolutionize our ability to **observe** the **lower troposphere** through Distributed Collaborative Adaptive Sensing (DCAS), vastly improving our ability to **detect**, **understand**, and **predict** severe storms, floods, and other atmospheric and airborne hazards”

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# What is CASA?

- National Science Foundation funded ERC
  - Academic, Government, and Private Sector Partners
- CASA's Focus: New weather observation system paradigm based on **low-power**, **low-cost networks** of **radars**.
- Faculty, students and industry/practitioners work in a **multi-disciplinary** environment on real-world technology.
- Year 6 of a 10-year research project

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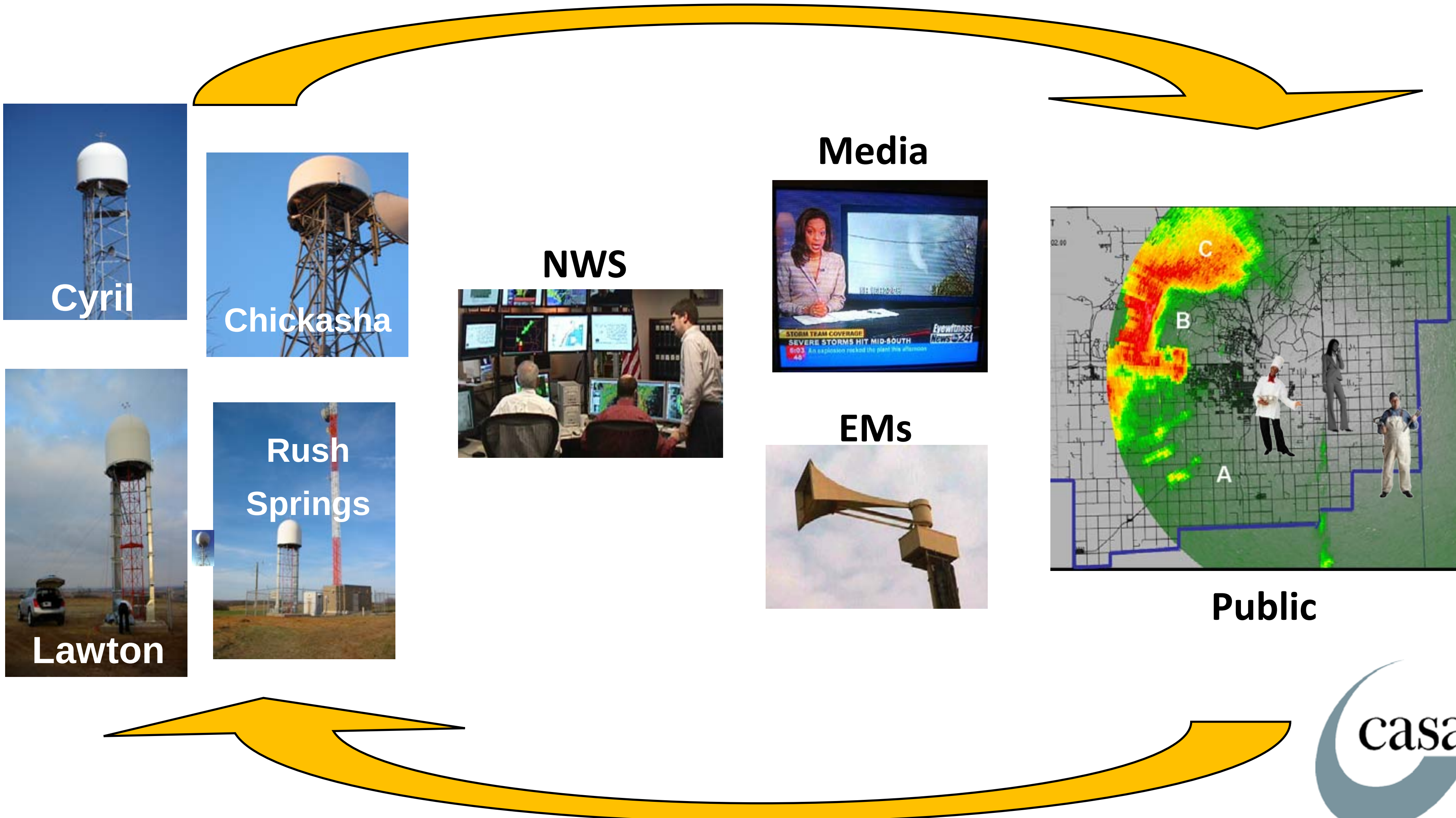
# Understanding how CASA Systems Impact Warning and Response

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# End-User Team Objectives

- Incorporate end-user needs into the system design from day one
- Identify users' perceptions:
  - Advantages & limitations of current weather observation and warning systems
  - How the media and public perceive, understand, and respond to weather forecasts and warning information
- Policy determinations and enhancing weather technology

# Background or Context

- CASA Social Scientists are focusing their research efforts on examining how improved forecasting can reduce the exposure and vulnerability of individuals and property to every-day and extreme weather events

- Through the use of field research, focus groups, in-depth interviews, and surveys, we are examining how the end-user community, particularly emergency managers and the general public, access, utilize, and respond to weather forecasts

- Use of both qualitative and quantitative approaches

# Research on Tornado Warnings

- Warning Process (Donner, 2007: Modified from Mileti and Sorenson, 1990):
  - Hearing the warning
  - Believing the warning is credible
  - Understanding the warning
  - Confirming that the threat does exist
  - Personalizing the warning and confirming that others are heeding it
  - Determining whether protective action is needed
  - Determining whether protective action is feasible
  - Determining what action to take and taking it

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# Qualitative Analysis

- Oklahoma emergency managers' and NWS meteorologists', spotters' knowledge, perceptions, and attitudes regarding severe weather events warnings

- Advantages, problems and limitations of current weather technology perceived by end-users and others in Oklahoma

- Data collection:
  - Structured surveys (n = 72)
  - In-depth interviews (n = 50)

# Qualitative Analysis

- Quick response research on tornadoes (n = 50)
  - New Orleans
  - Missouri
  - Tennessee
- Data from case-study tornado scenarios in Oklahoma
  - Lawton
  - Minco
  - Arnett
- Quick response research in Louisiana and Mississippi to observe the effects of Hurricane Katrina on communities

# Quantitative Approach: Objectives

- Explore and describe **public response** and the household **decision making** process following a severe weather warning or a hazard event: **actual response**

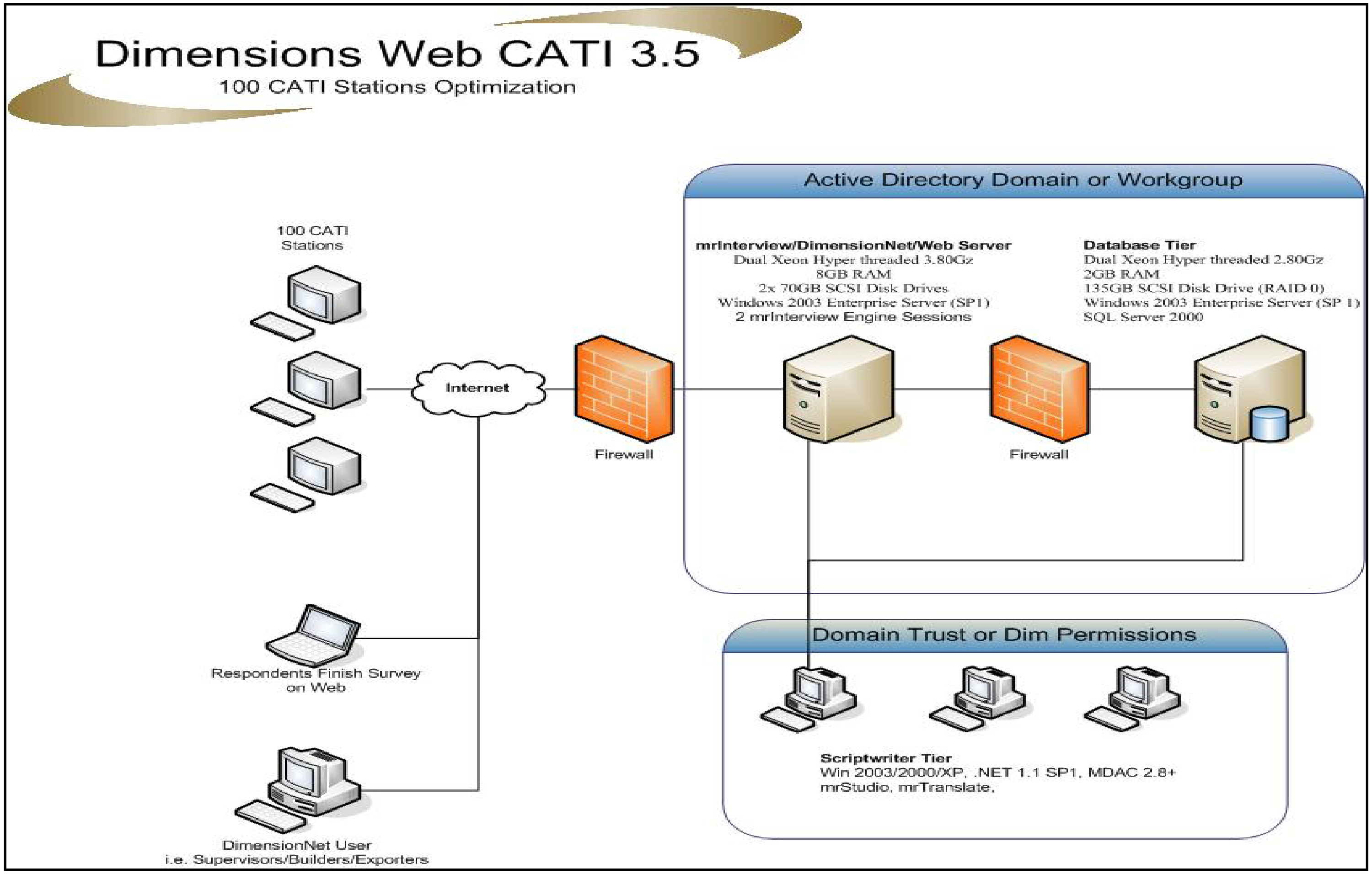
- Computer Assisted Telephone Interviewing (**CATI**): Survey exploring public response to four (4) severe weather warning/events in communities in Kansas, Minnesota, Oklahoma, and Illinois in 2008

- Quantitative and predictive models, which are based on extensive qualitative research with emergency managers and the general public following severe weather events

# Methodology

- Sampling
  - GENESYS Sampling Systems: Full service sampling company that provides a wide variety of services to the survey research community
  - Genesys provided samples based on DRC sampling requests in the impacted areas
  - Three attempt calling rule and activating CATI calling center at different times of the day
  - Calls were made 1-3 weeks after event
  - Total Interviews: 268

# CATI Architecture



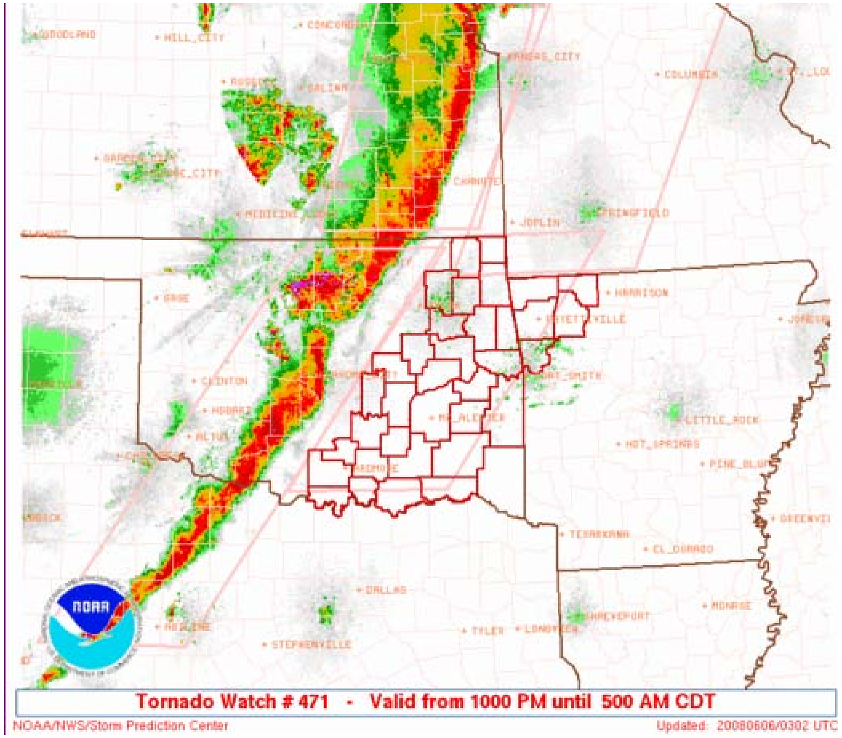

Courtesy of SPSS

# Questionnaire

- 127 questions in total yielding about 429 variables:
  - Severe storm/tornado impact
  - Confirmation/verification
  - Sources of information
  - Communication
  - Protective action, including seeking shelter
  - Damage to property
  - Insurance coverage
  - Lead time, watch, warnings, false alarms
  - Previous experience with hazards
  - Perceptions/trust
  - Preparedness
  - Demographic and socio-economic variables
  - Disabilities

# Oklahoma

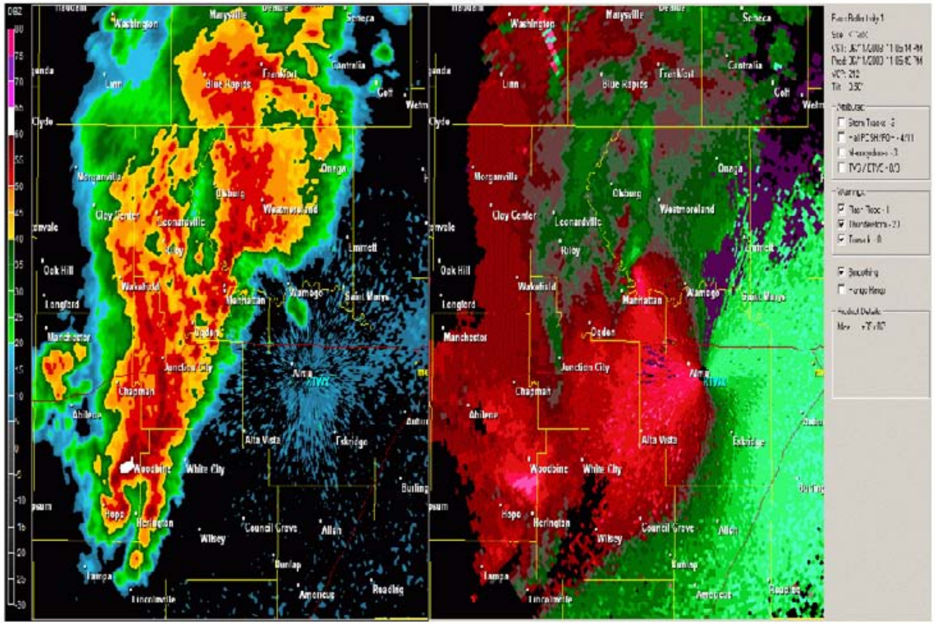
- June 5, 2008, 11:50 AM: NWS issued a tornado watch for parts of central Kansas and Northwest Oklahoma
- 10:00PM: Tornado warning for Northwest Arkansas and Eastern Oklahoma
- 11:51PM: Line of storms moved to central Okmulgee county and southwest Tulsa county. Winds measuring up to eighty miles per hour in southwest Tulsa County
- No tornado touchdown ("False Alarm")
- No fatalities or injuries
- Outages for 19,611 Oklahoma Gas and Electric customers (47,400 statewide) and numerous downed power lines




Source: NOAA's National Weather Service Storm Prediction Center. "Tornado Watch 471." June 5, 2008. <http://www.spc.noaa.gov/products/watch/ww0471.html>

# Kansas

- June, 11, 2008, 10:00PM: Two super-cell thunderstorms caused **4 tornadoes** and extensive damage across Northeast Kansas
- The second tornado (F4)
  - Manhattan, Kansas
  - About **$27 million** worth of damages to Kansas State University
  - **Destroyed 47 homes** and 3 businesses; major damage to over 70 homes and 10 businesses



**Source:** National Oceanic and Atmospheric Administration (NOAA). 2008. NOAA National Weather Service Weather Forecast Office in Topeka, KS. “Tornadoes Strike Northeast Kansas.” June 11. Retrieved November 3, 2008. (http://www.crh.noaa.gov/top/?n=11june2008.)

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# Minnesota

- July 11, 2008: Squall line of thunderstorms formed and tracked across Minnesota; several individual super cell-like thunderstorms developed
- 6:36PM: NWS issued a **tornado warning** for NE Kandiyohi County
- Two minor injuries and no fatalities
- Eleven homes and three businesses were affected by the **tornado**

Sources: National Oceanic and Atmospheric Administration (NOAA). 2008. NOAA National Weather Service Weather Forecast Office in Willmar, MN and FOX News. Retrieved November 3, 2008. (www. crh.noaa.gov/images/mpx/71108_1.JPG and http://www.foxnews.com/story/0,2933,381221,00.html)

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# Illinois

- August 4-5, 2008: Ten tornados, ranging from F0 to F2, were reported, of which 5 were confirmed for NW Indiana and N. Illinois
- 7:15PM: Watch in NE Illinois, NW Indiana, and SW Michigan
- 7:24PM: Tornado warning issued for Cook, DuPage, and Kane Counties in Illinois
- 8:01PM: Tornado reported by Emergency Management Office in DuPage County
- 8:14PM: Tornado warning issued for Cook County, Illinois, including Chicago
- Two deaths
- Damages to 25 homes
- Power service interruptions to 288,000 residences
- 350 flight cancellations out of O'Hare International Airport

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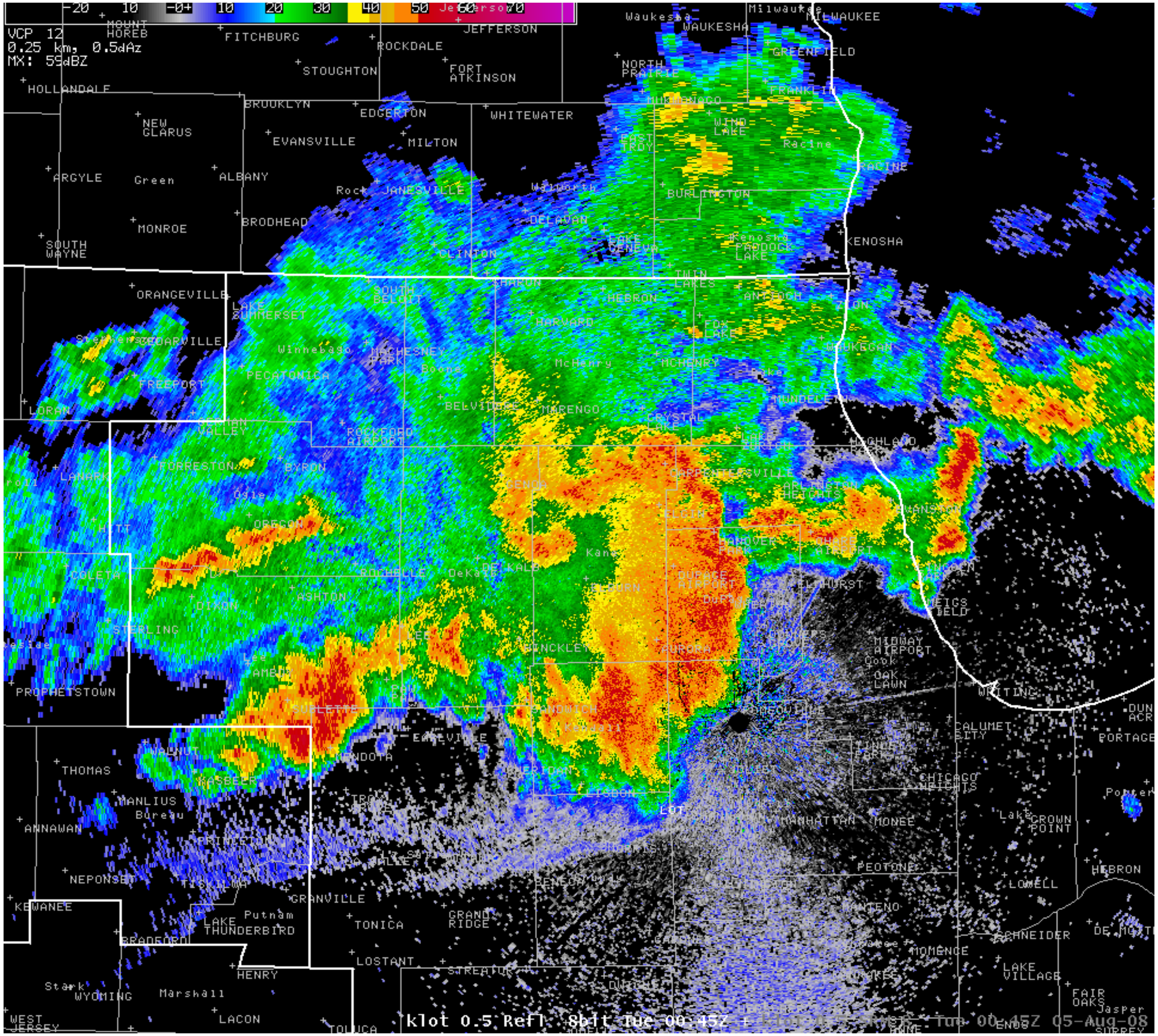
# Illinois

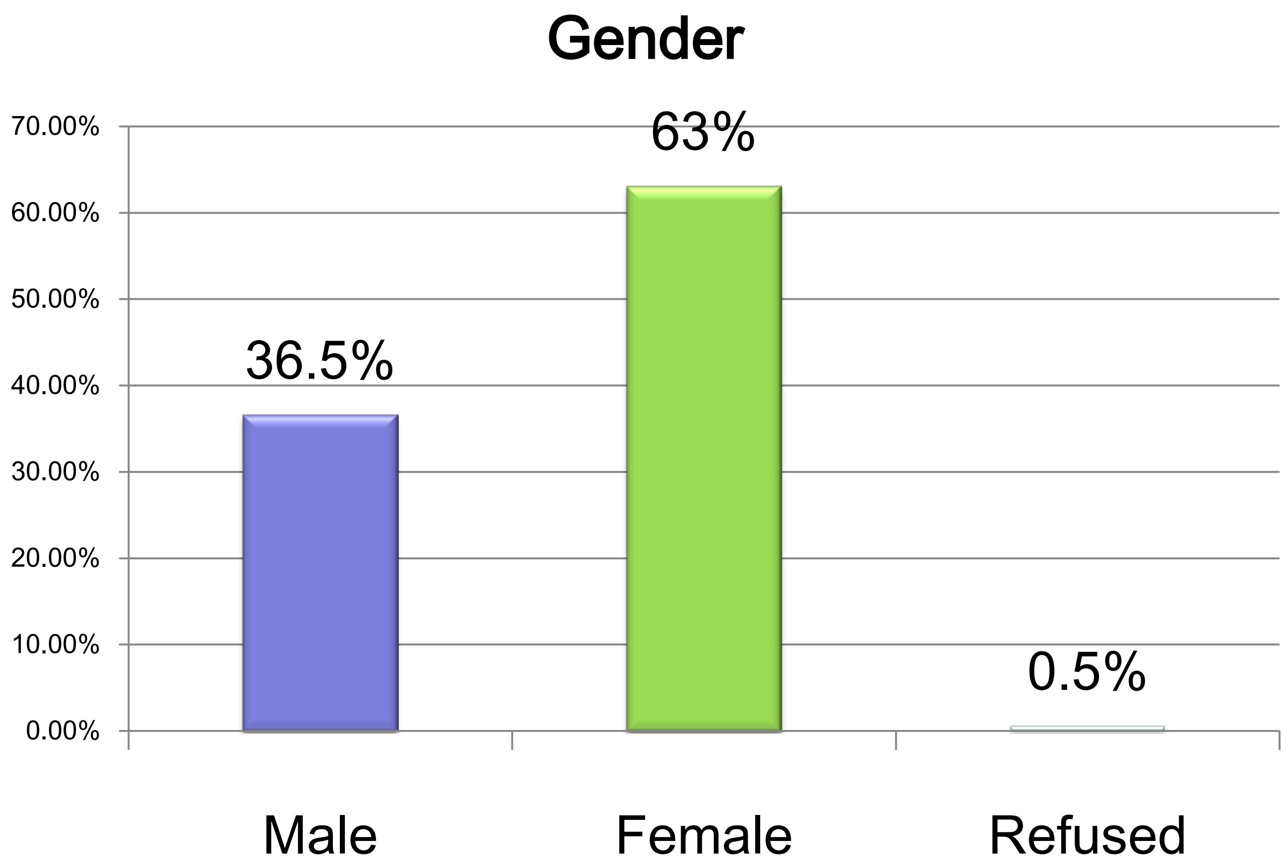



Source: National Oceanic and Atmospheric Administration (NOAA). 2008. NOAA National Weather Service Weather Forecast Office in Chicago, IL. “August 4th Tornadoes and Damaging Winds (Updated Information).” August 15. Retrieved August 19, 2008.

# Sample

- 268 interviews completed
  - 23 in Tulsa County, Oklahoma
  - 112 in Riley County, Kansas
  - 76 in Kandiyohi County, Minnesota
  - 57 in DuPage County, Illinois
- Average duration of interviews: 35 minutes

# Demographic Characteristics



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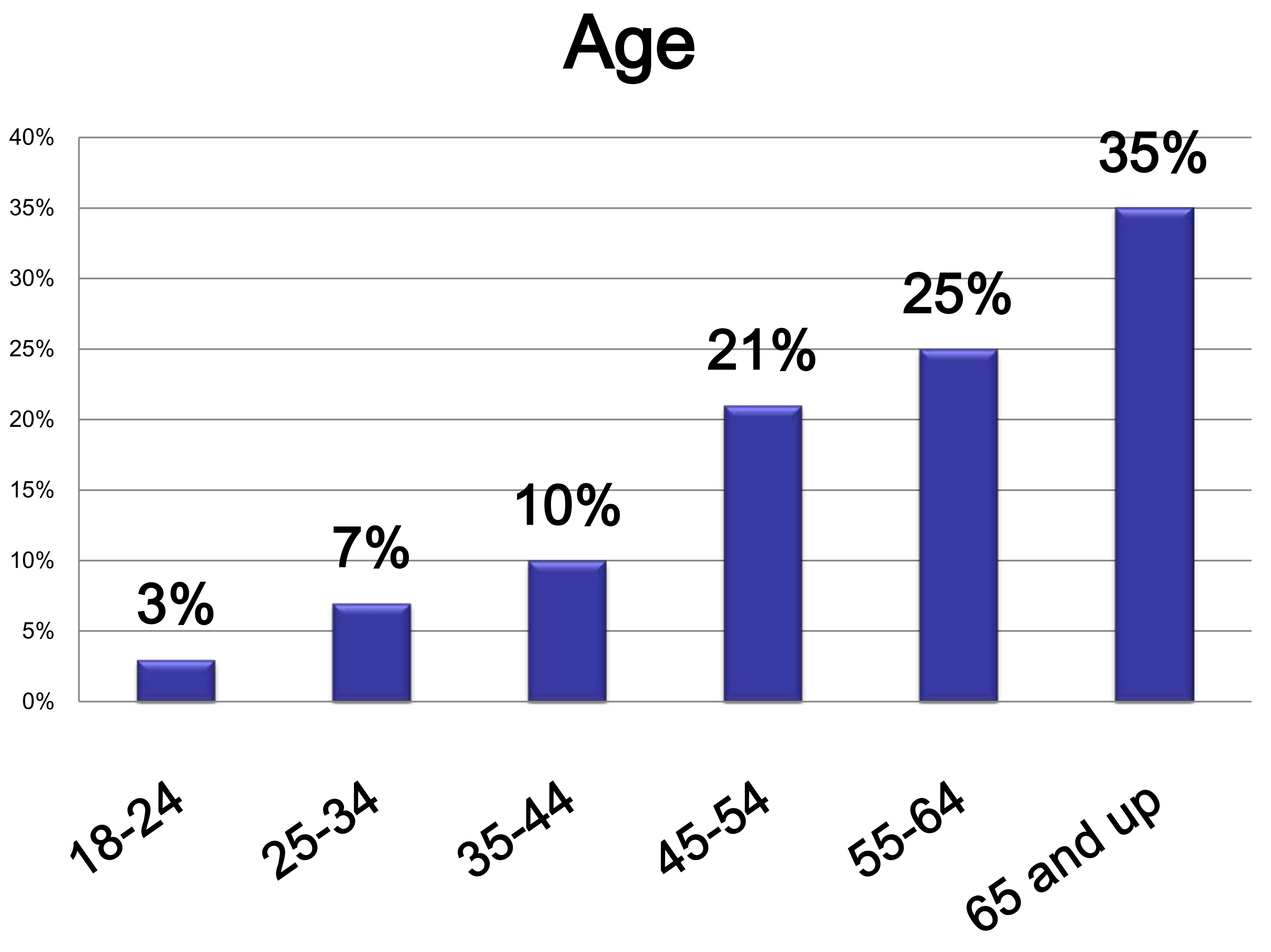


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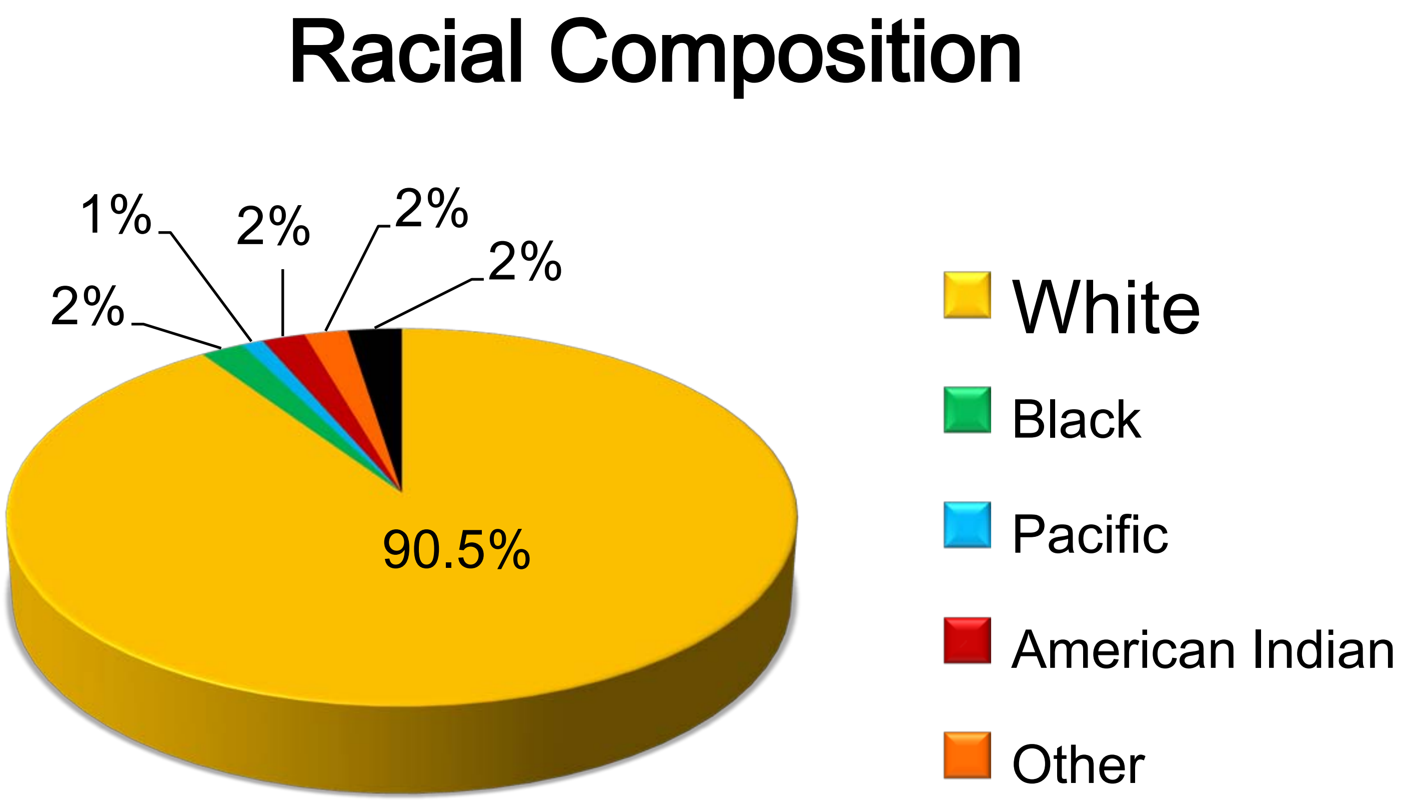
# Demographic Characteristics



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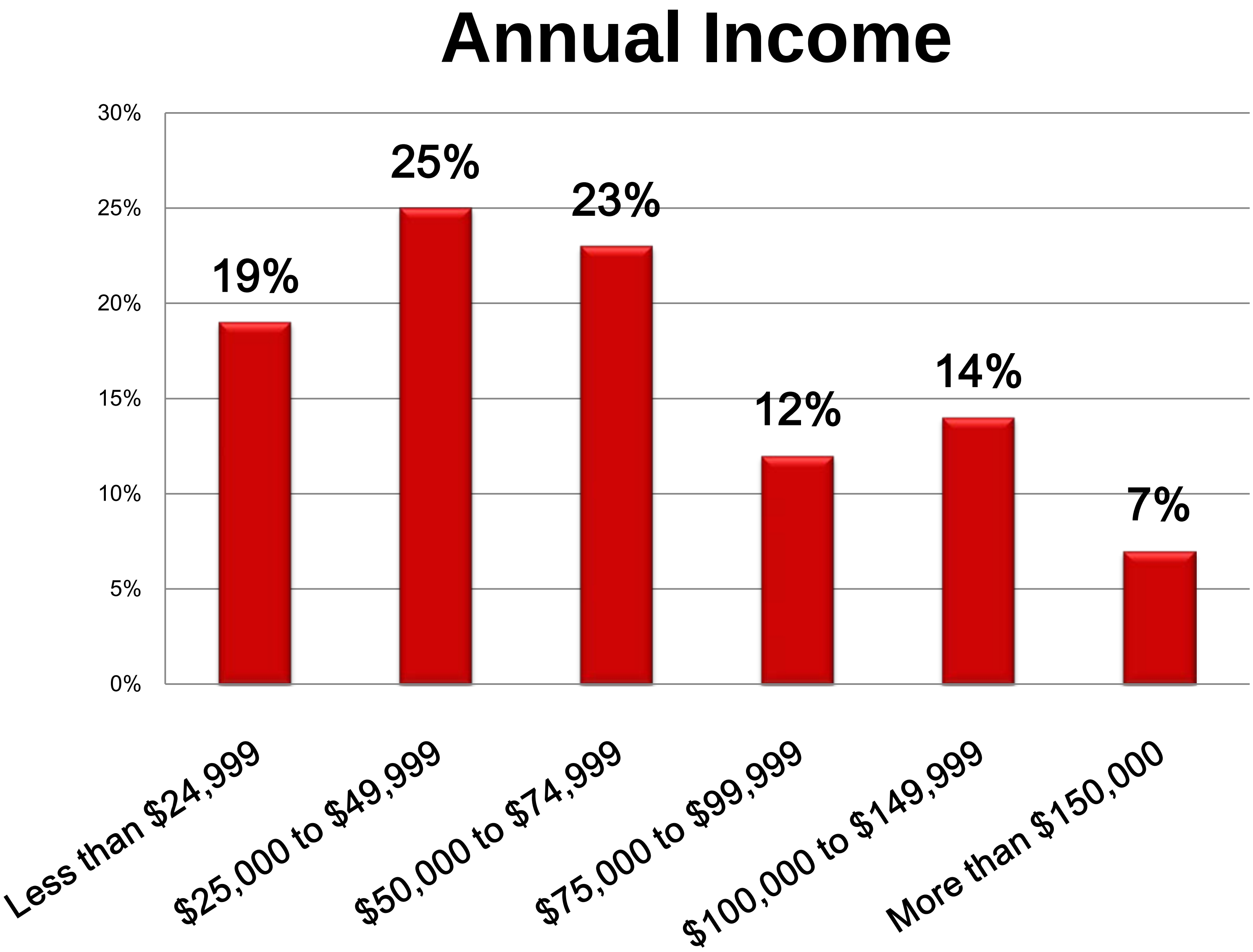
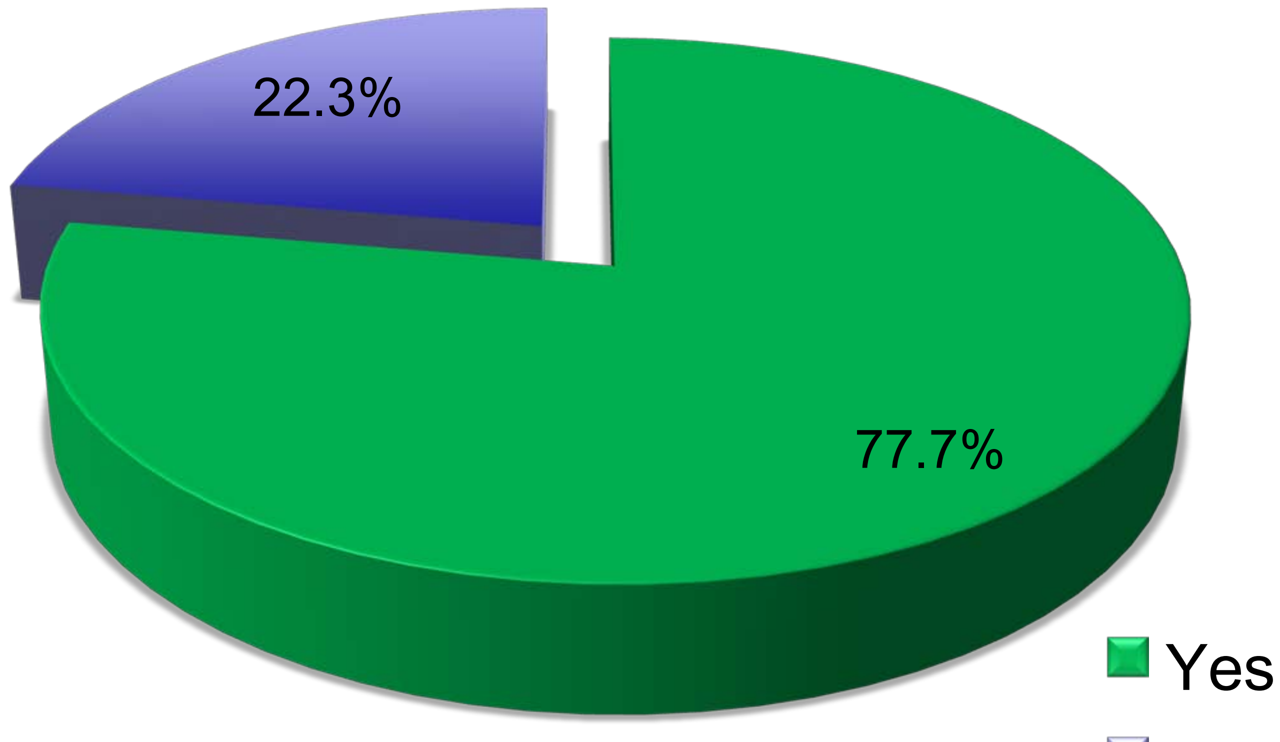
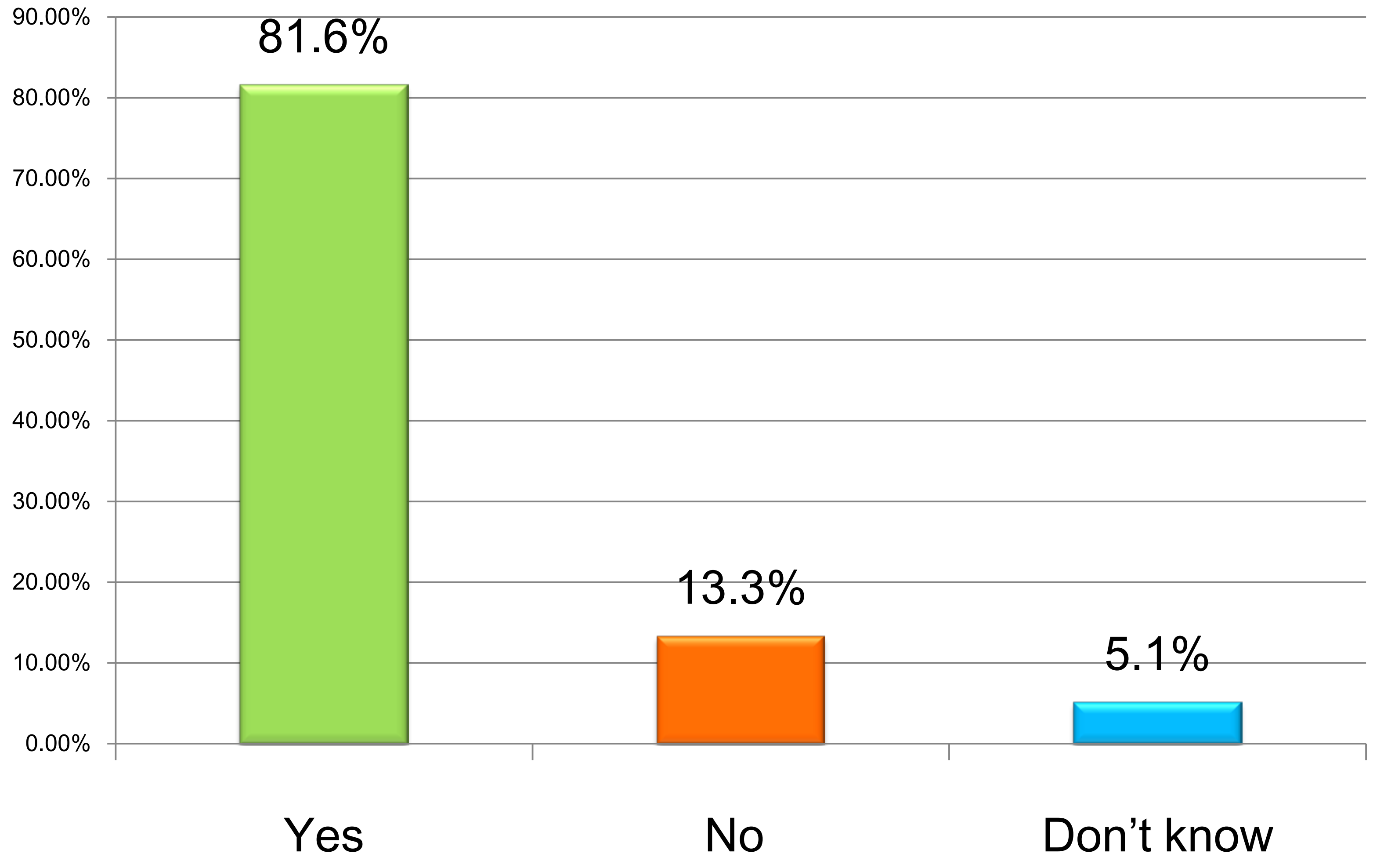


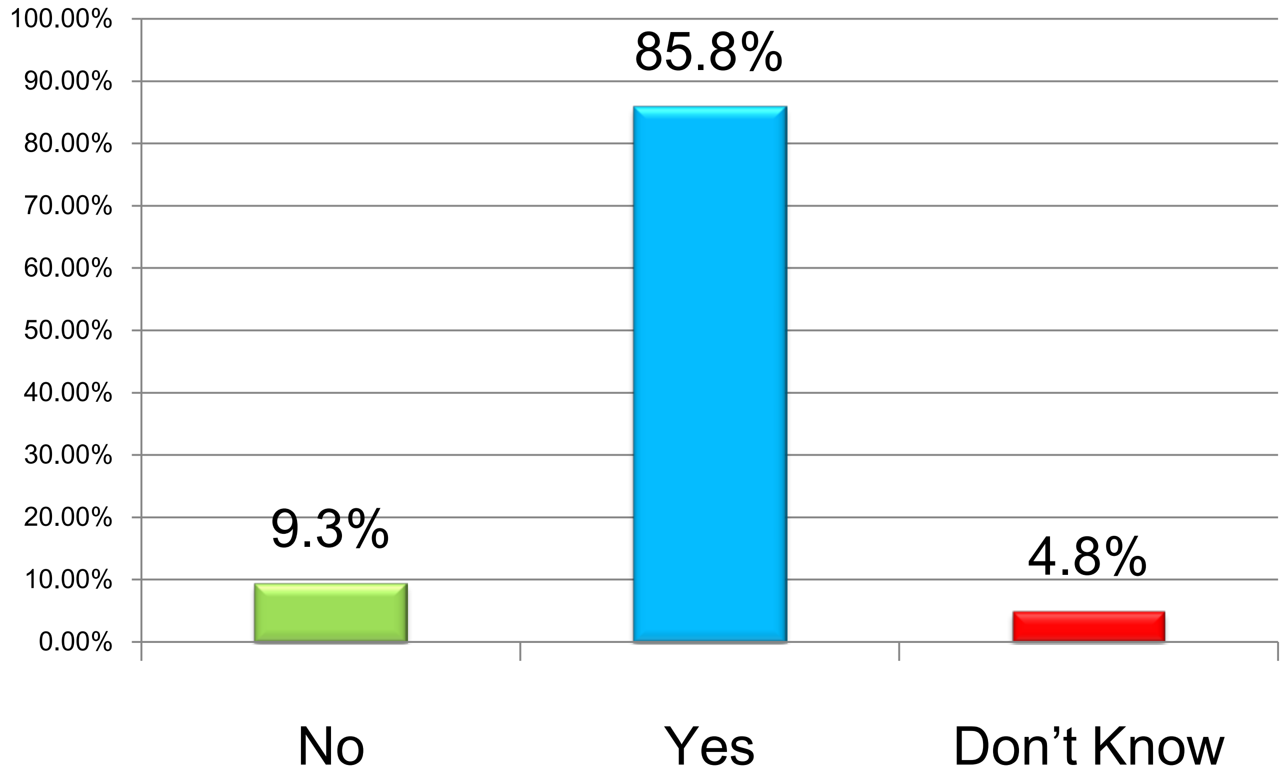
# Were you in the area on the date of the event?



# Were you aware that a tornado or severe storm had been observed in the surrounding area before it got to your town?



# Did you receive a warning or notification of a tornado or severe storm in your region?

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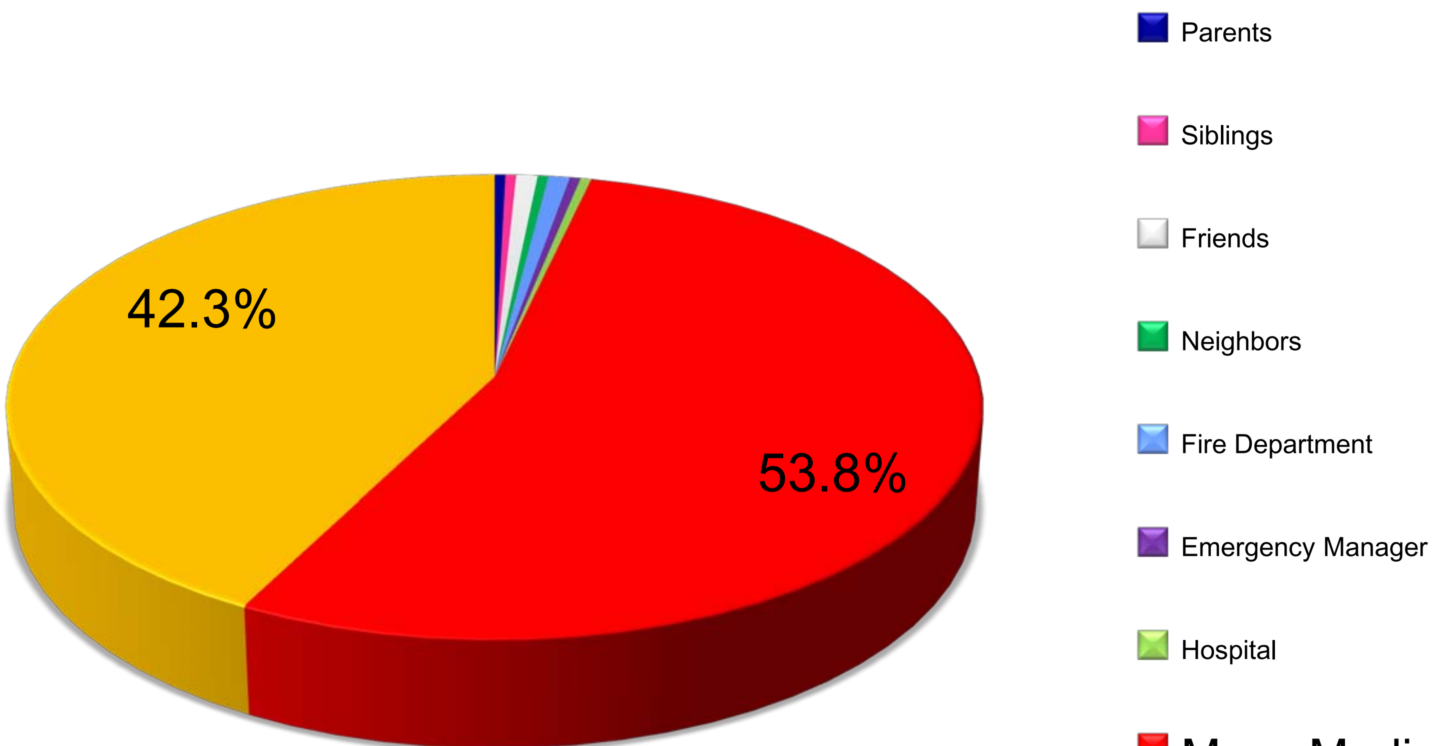
# From whom did you receive this information?

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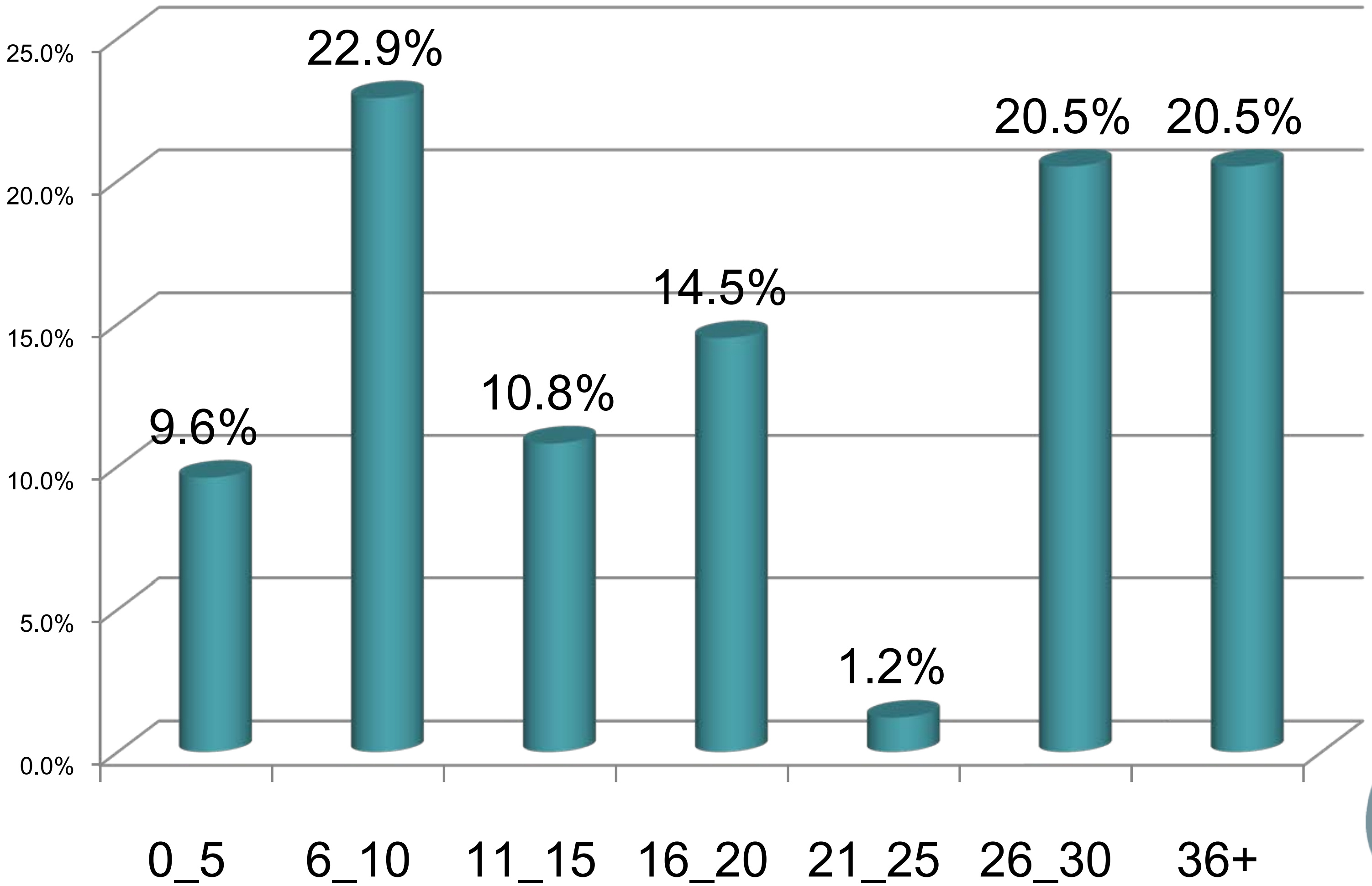
## When you first found out a tornado or severe storm was present inside or near your town or city, about how many minutes did it take before it hit your neighborhood? (Average = 27.9 minutes)

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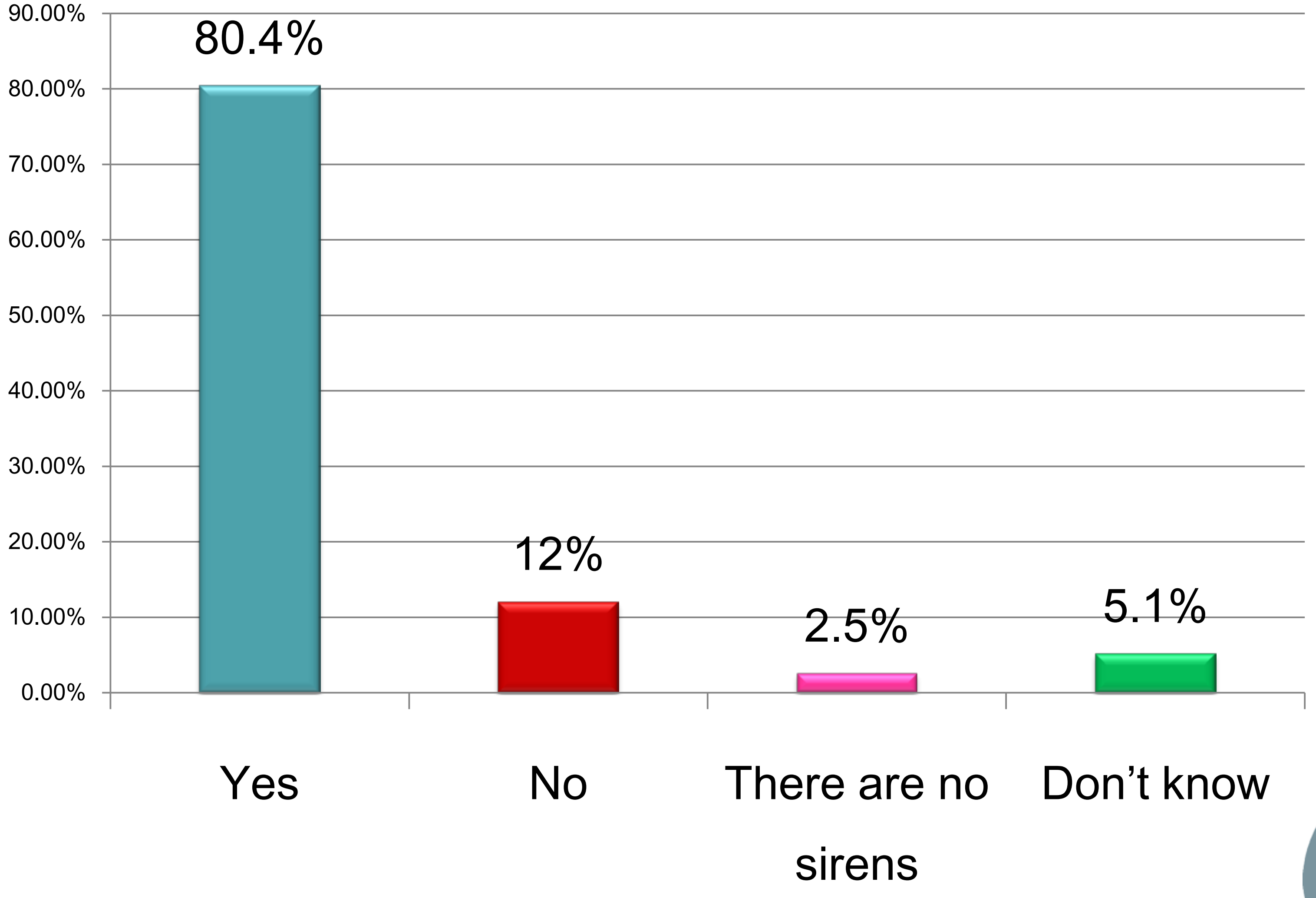
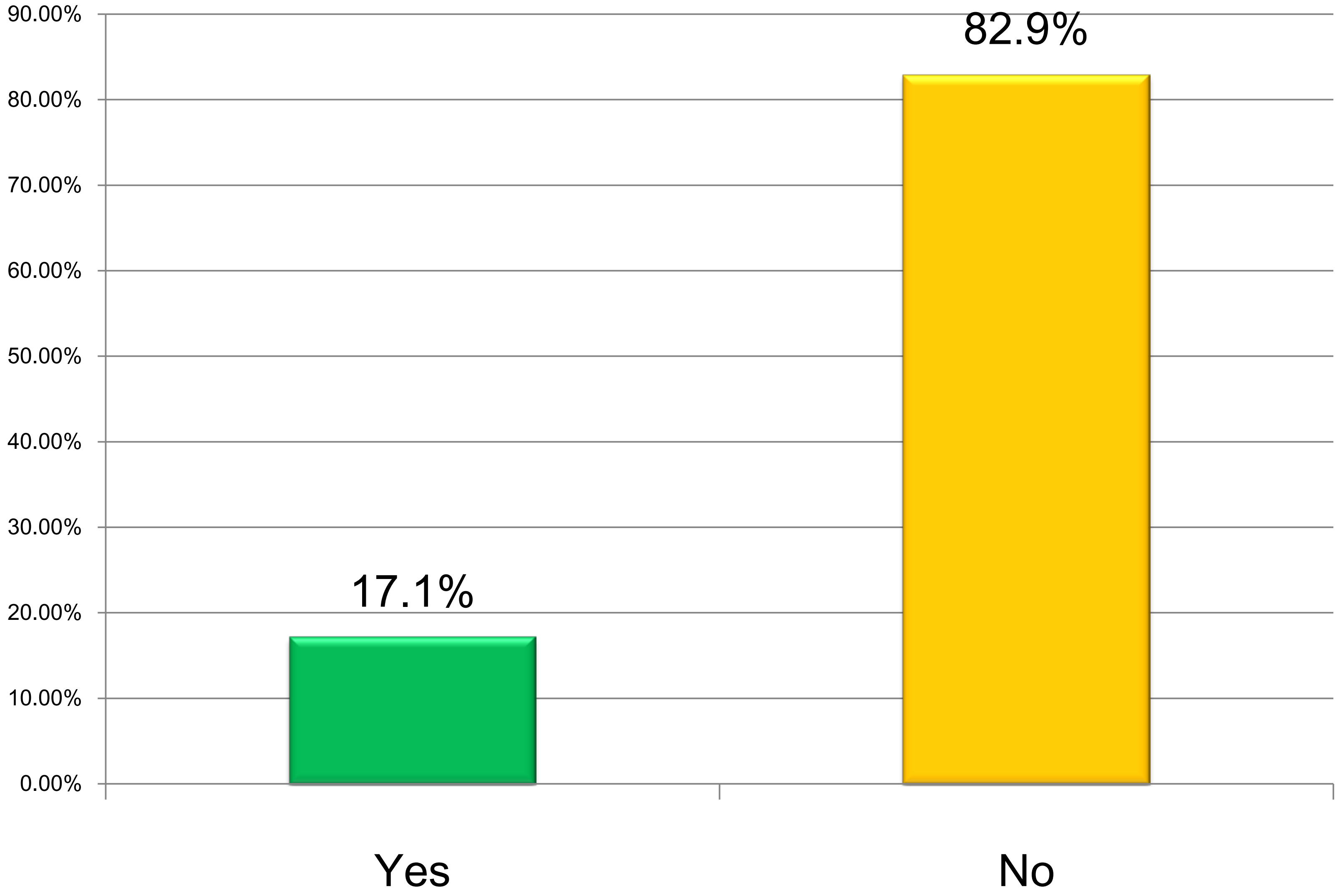
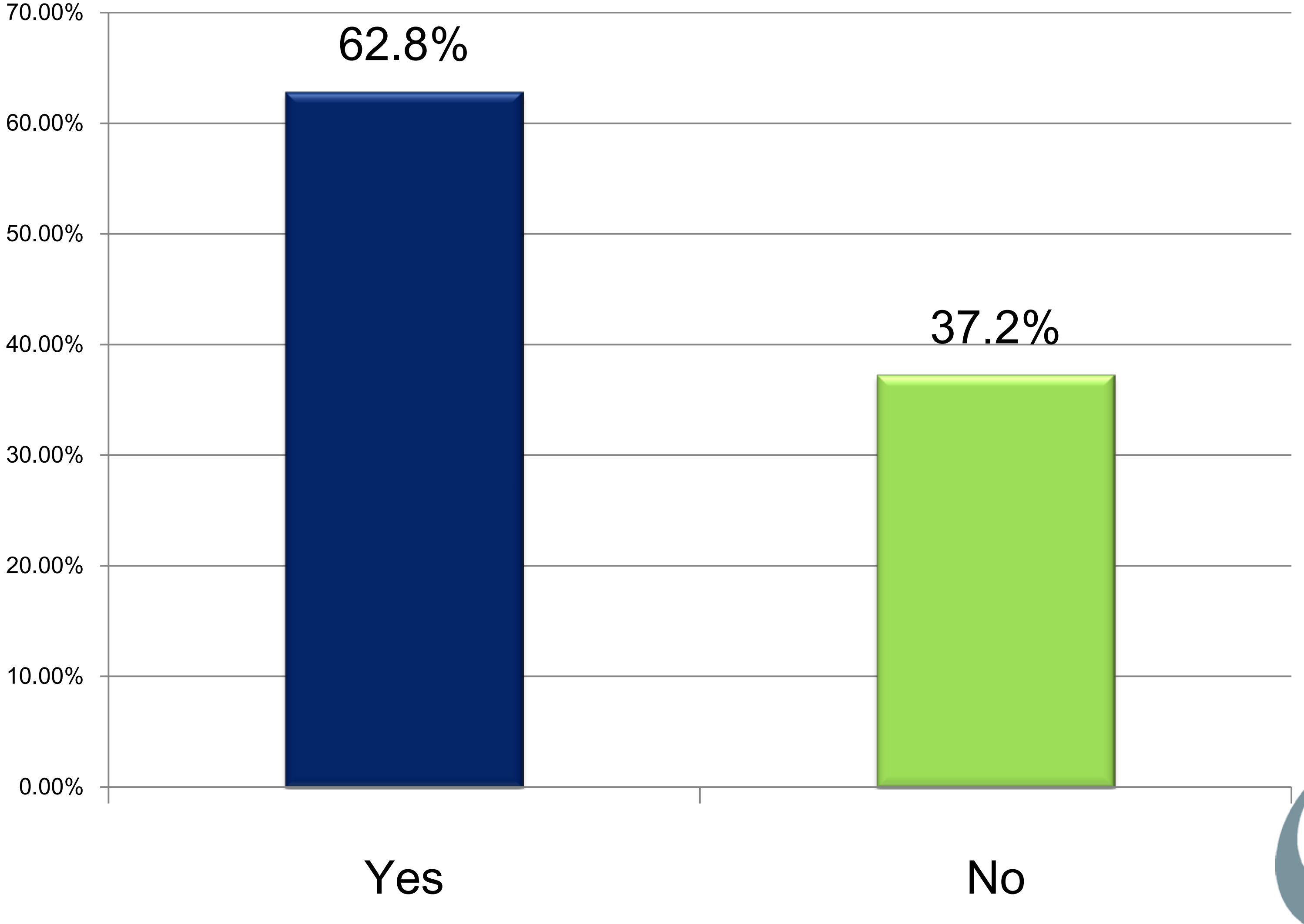
# Did the tornado sirens in your community go off?



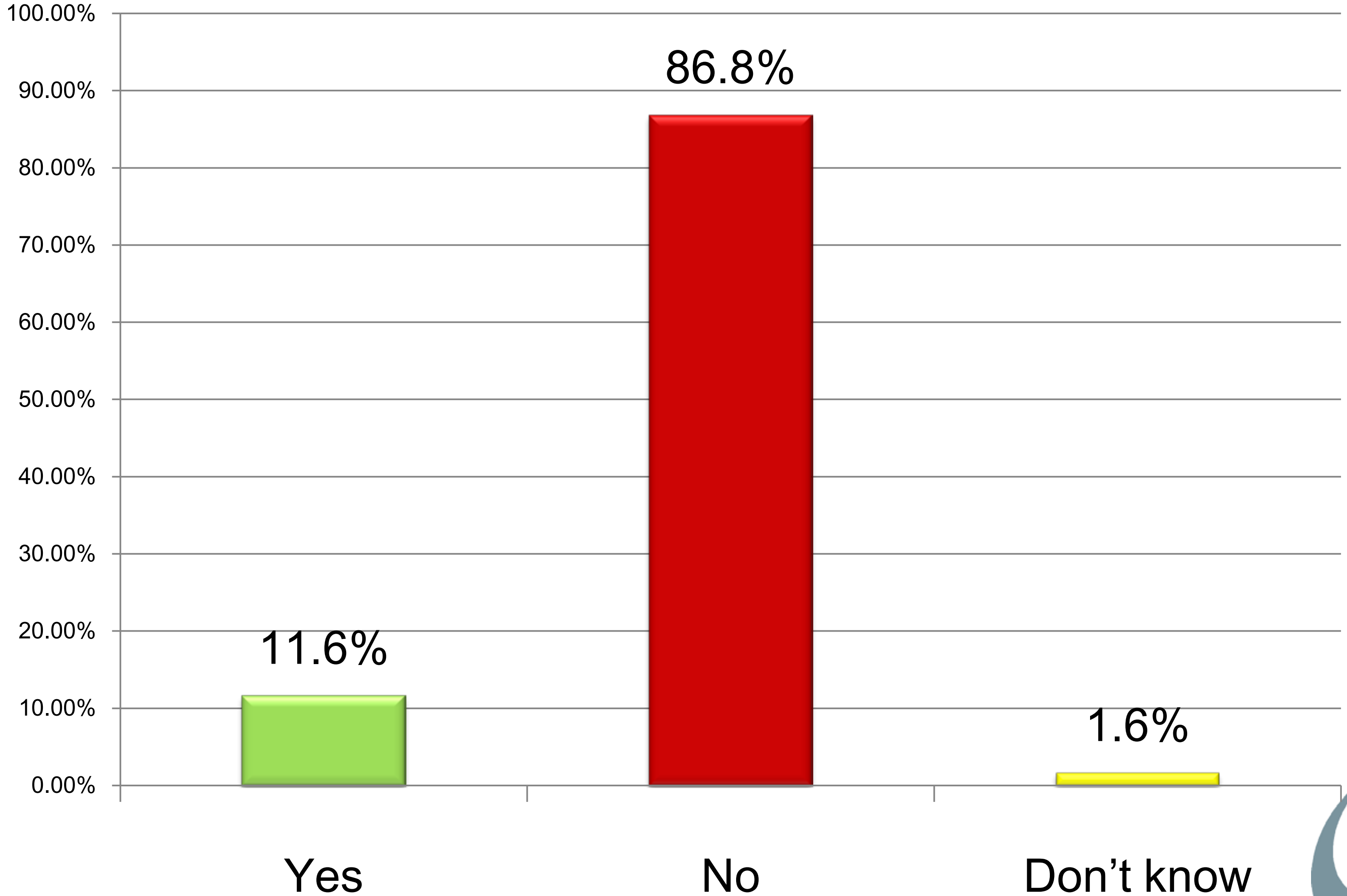
# Did you contact someone to confirm information about the impending tornado or severe storm?



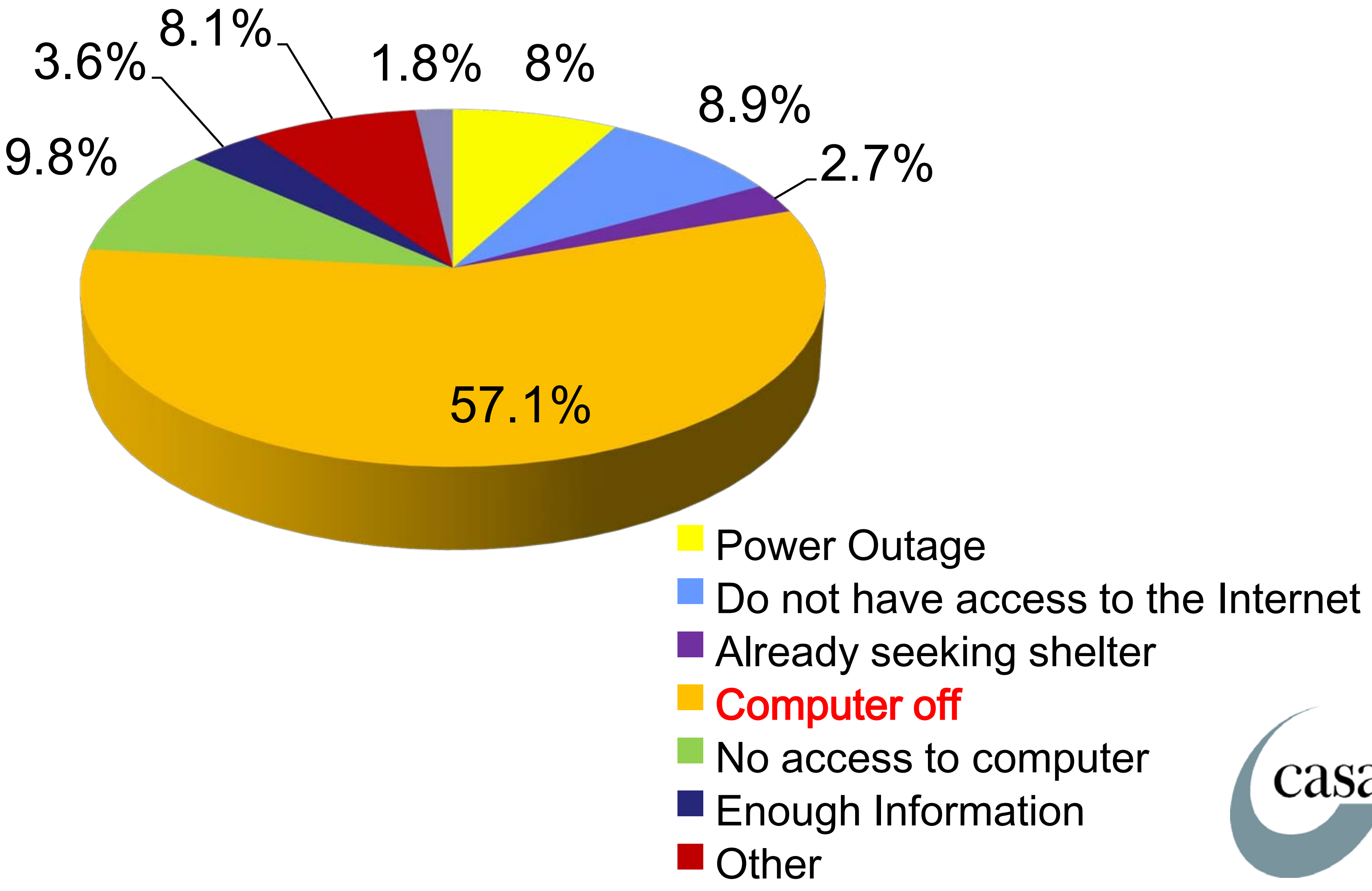
# Did you look outside to verify whether the tornado or severe storm was coming?



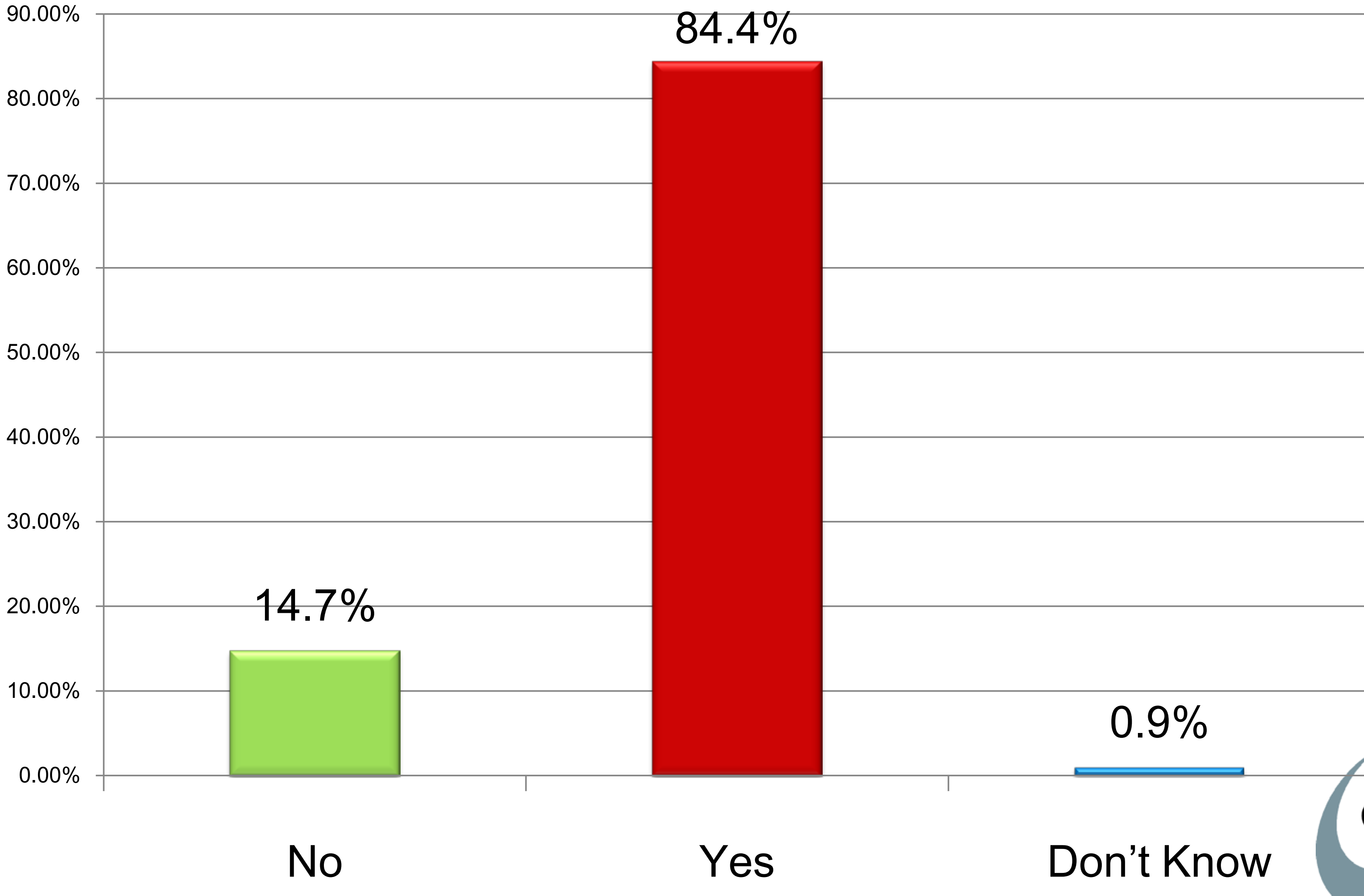
# Did you receive information from the Internet during the last 30 minutes before the tornado or severe storm arrived?



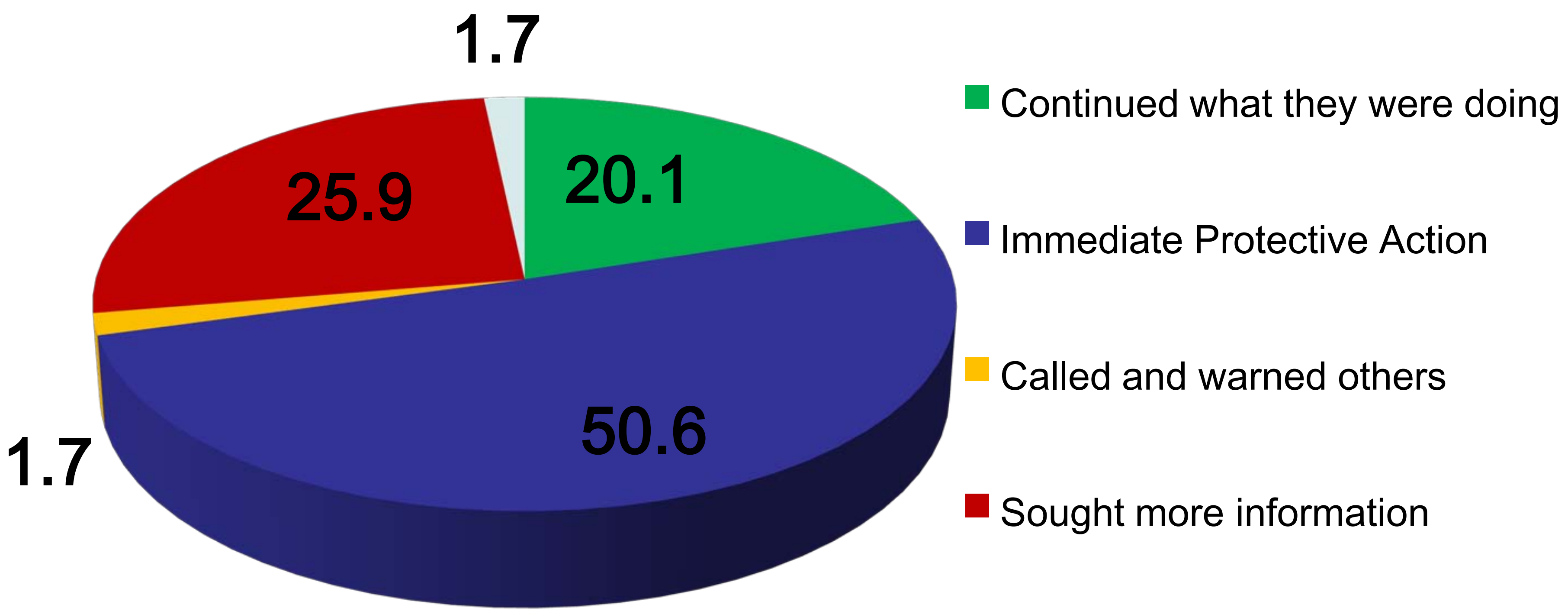
# Why did you not receive information from the internet?



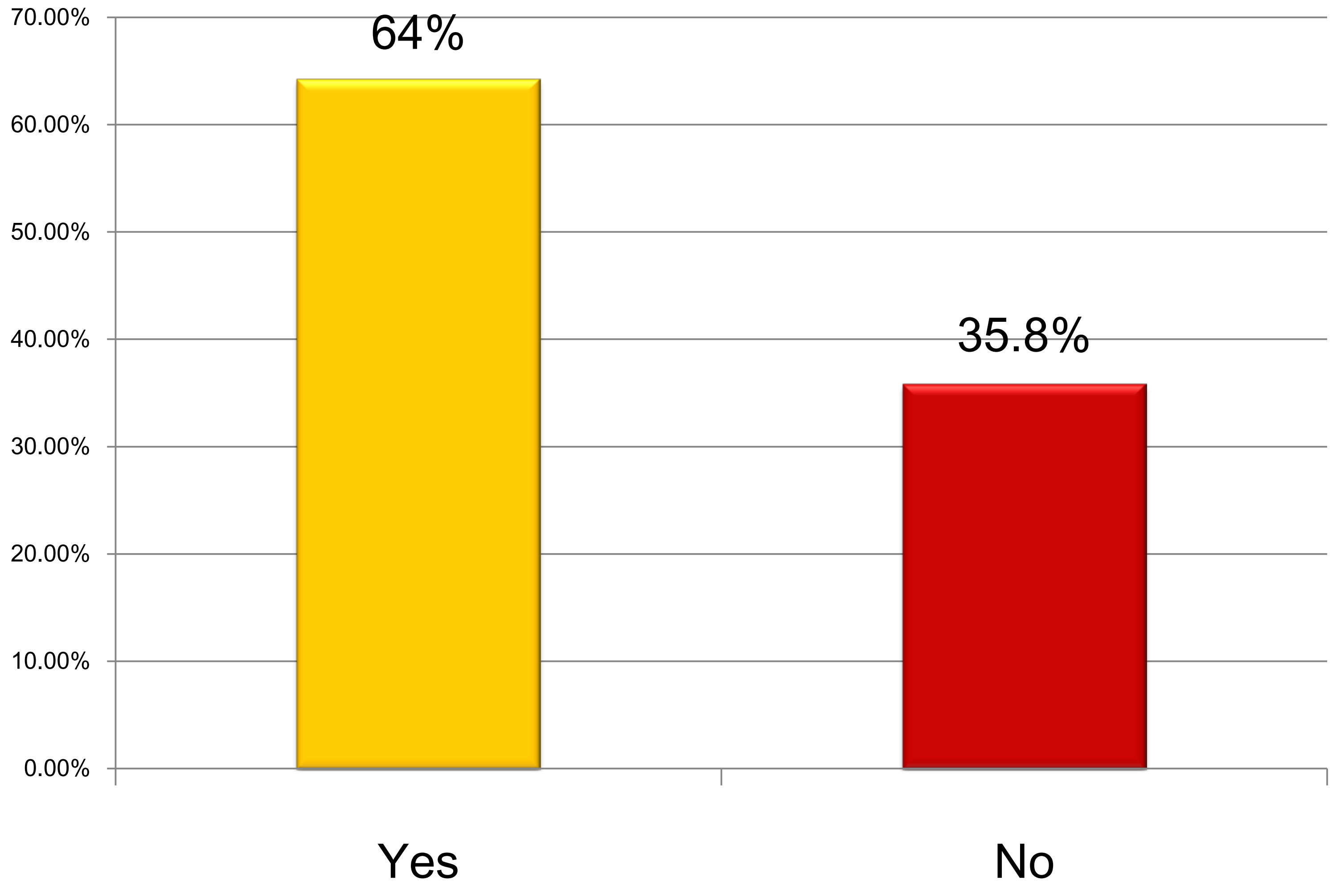
# Did you receive information from the TV during the last 30 minutes before the tornado or severe storm arrived?



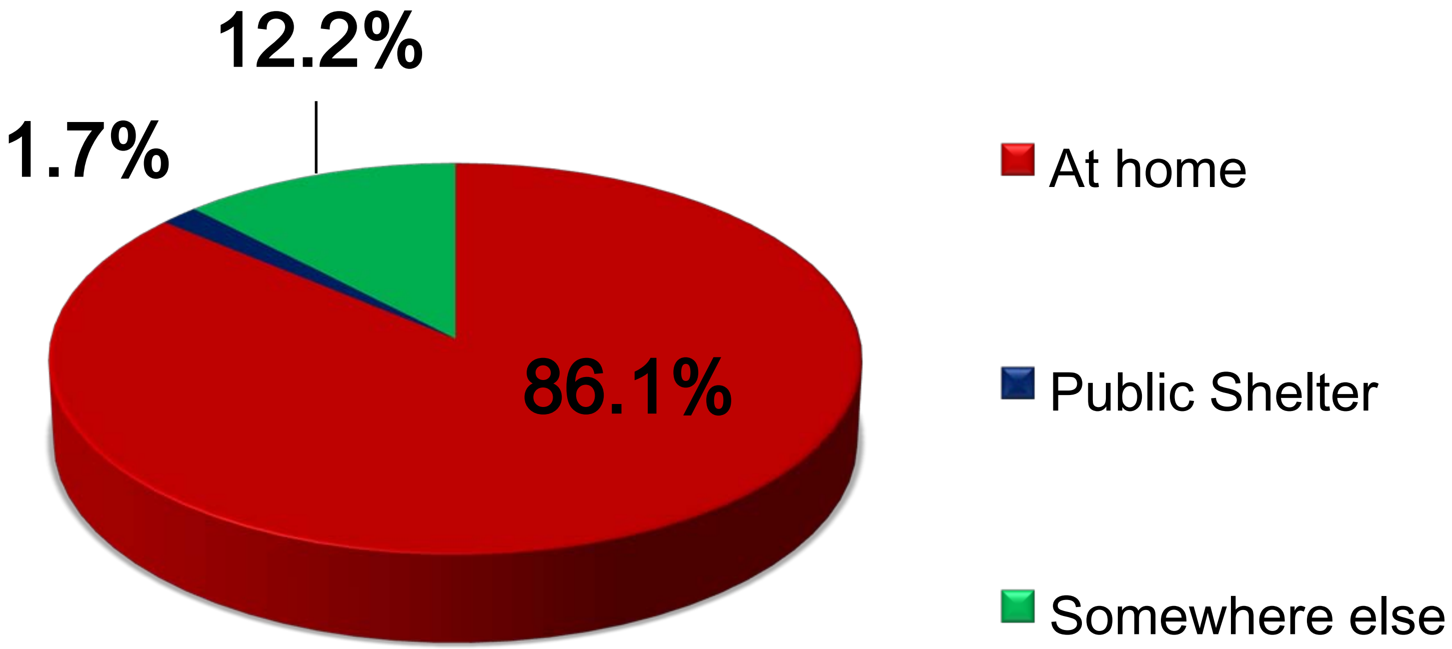
## After receiving the warning or notification, what did you do?



## Did you take any actions to protect yourself, your family, or your property from the hazard event?

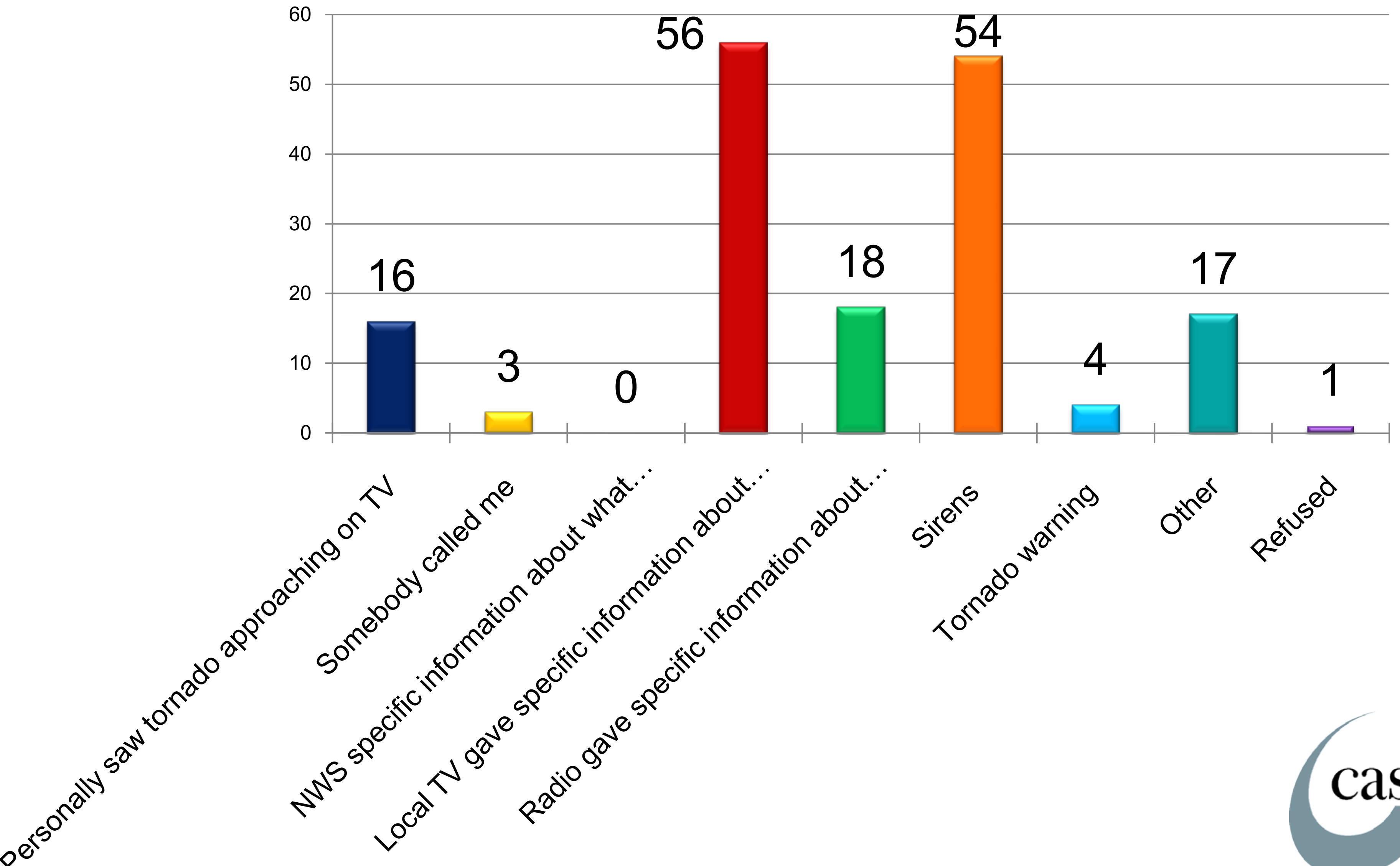


# Where did you take protective action?



# What information led you to seek shelter?

(n = 169)

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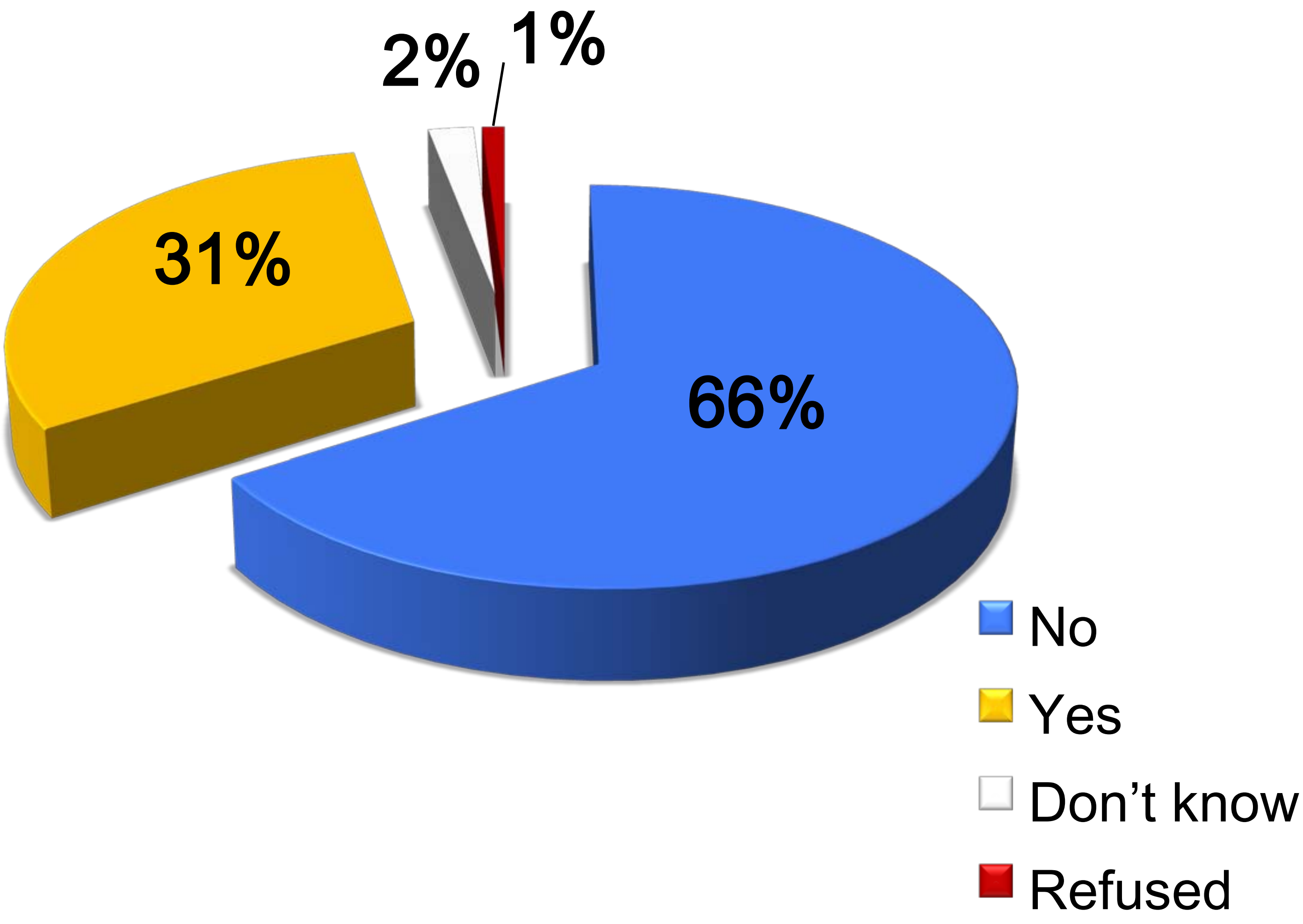
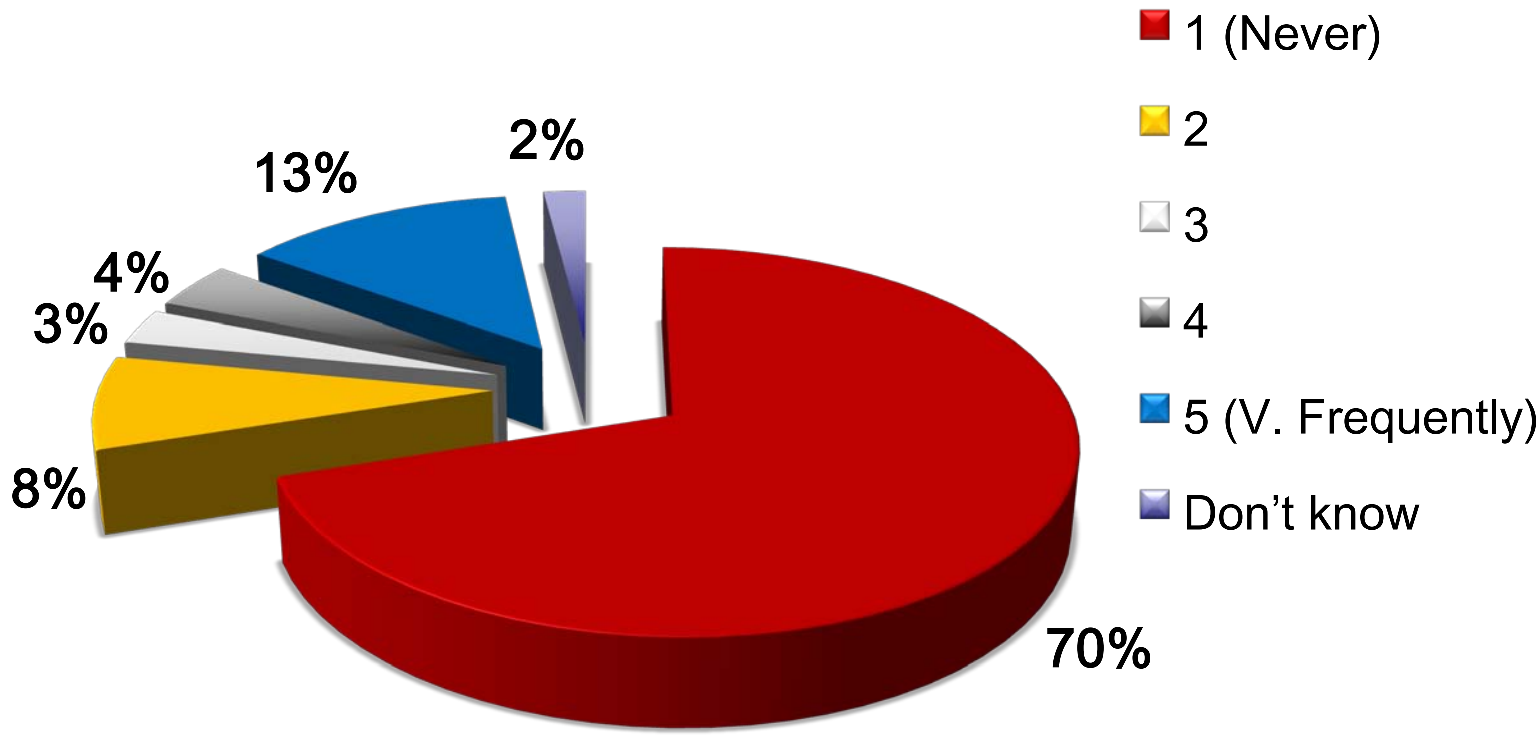
# NOAA Radio Ownership

Do you own a NOAA weather radio?



# How often would you say you listen to a NOAA radio for information about tornadoes or severe storms?

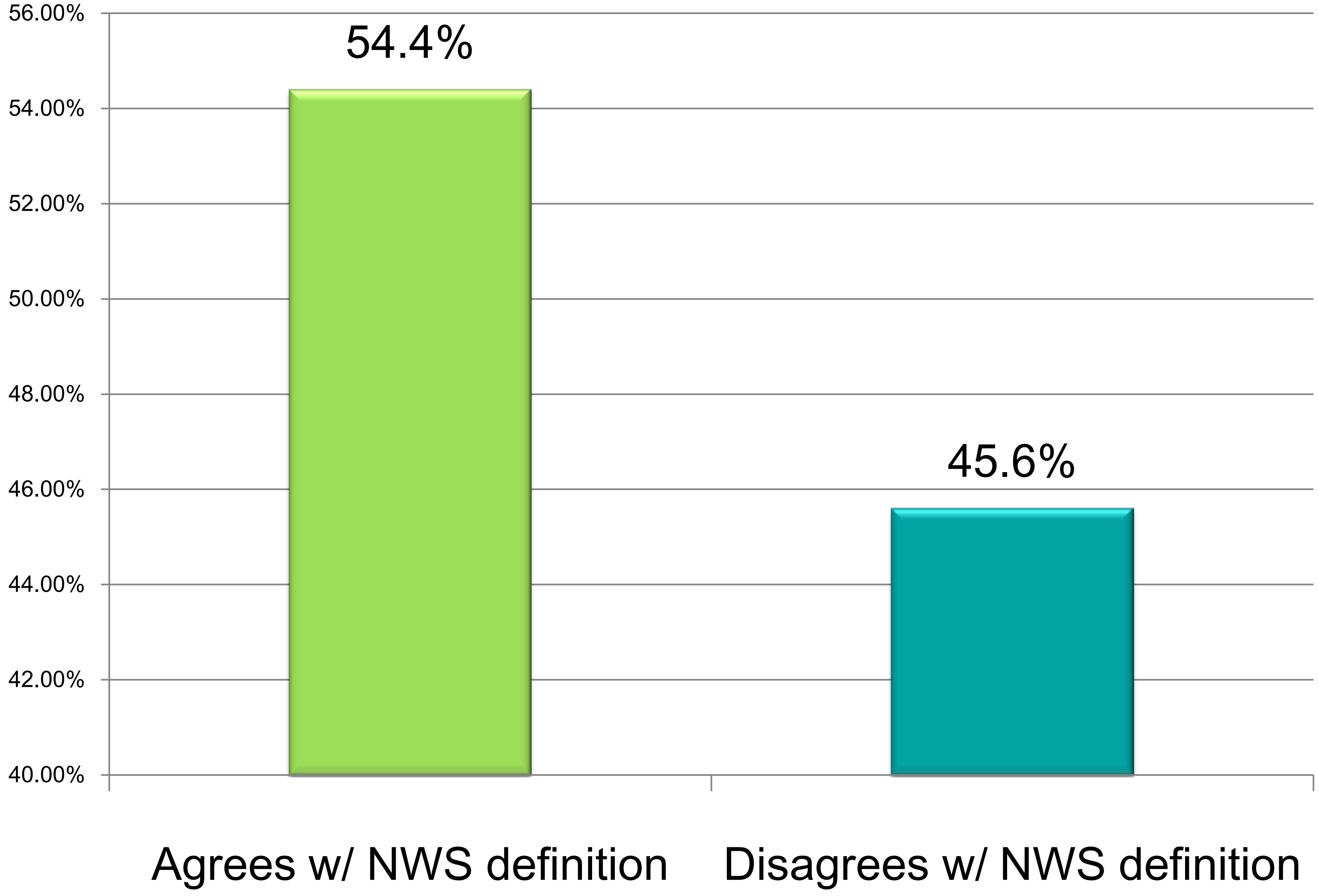


# Tornado Watch & Warning and False Alarms

- Respondents appear to have some difficulty understanding the differences between watches and warnings and what is a false alarm

- Participants seem to understand that watches and warnings represent some type of danger, but they are unable to clearly differentiate between these two concepts

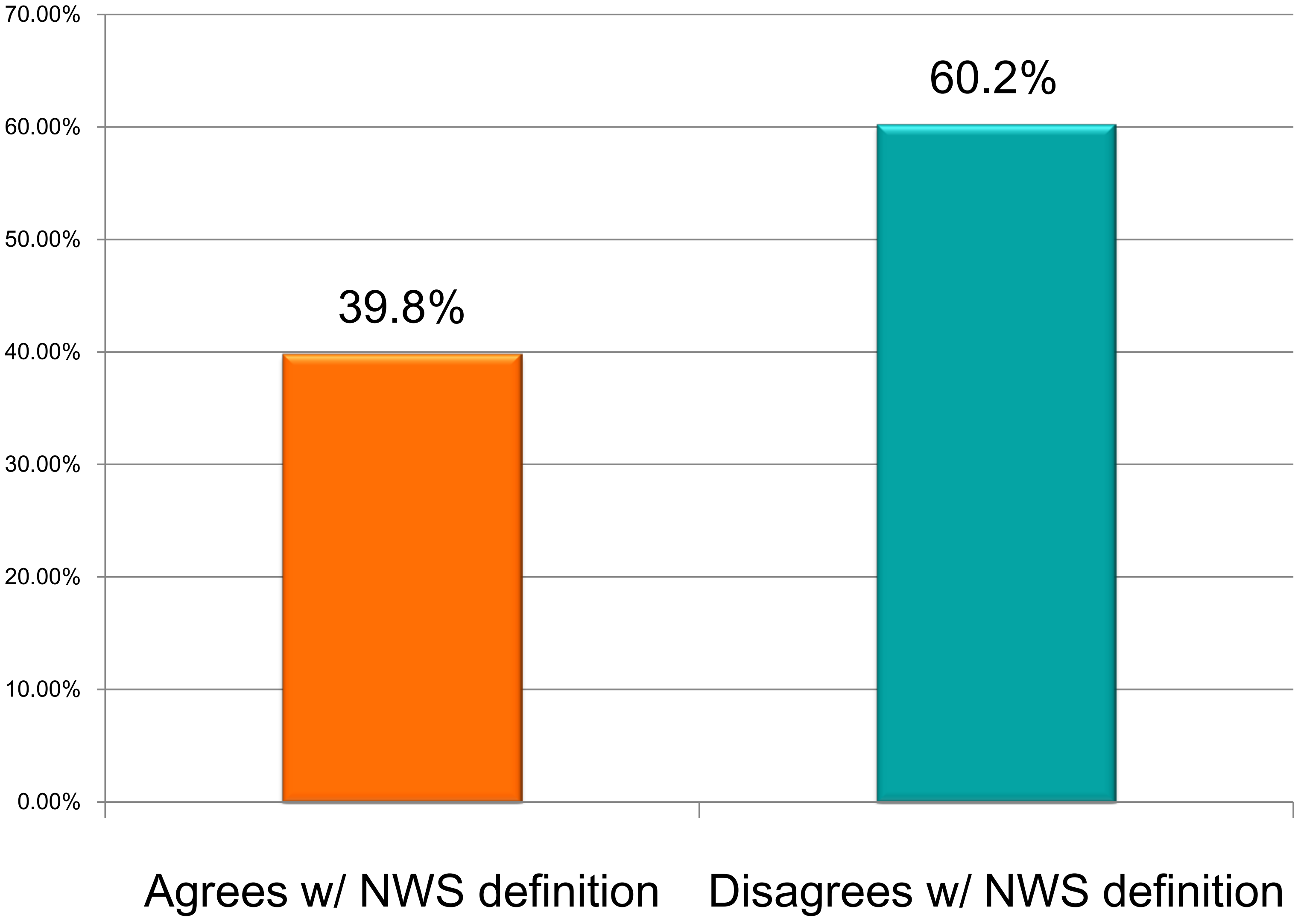
# Watch Definition



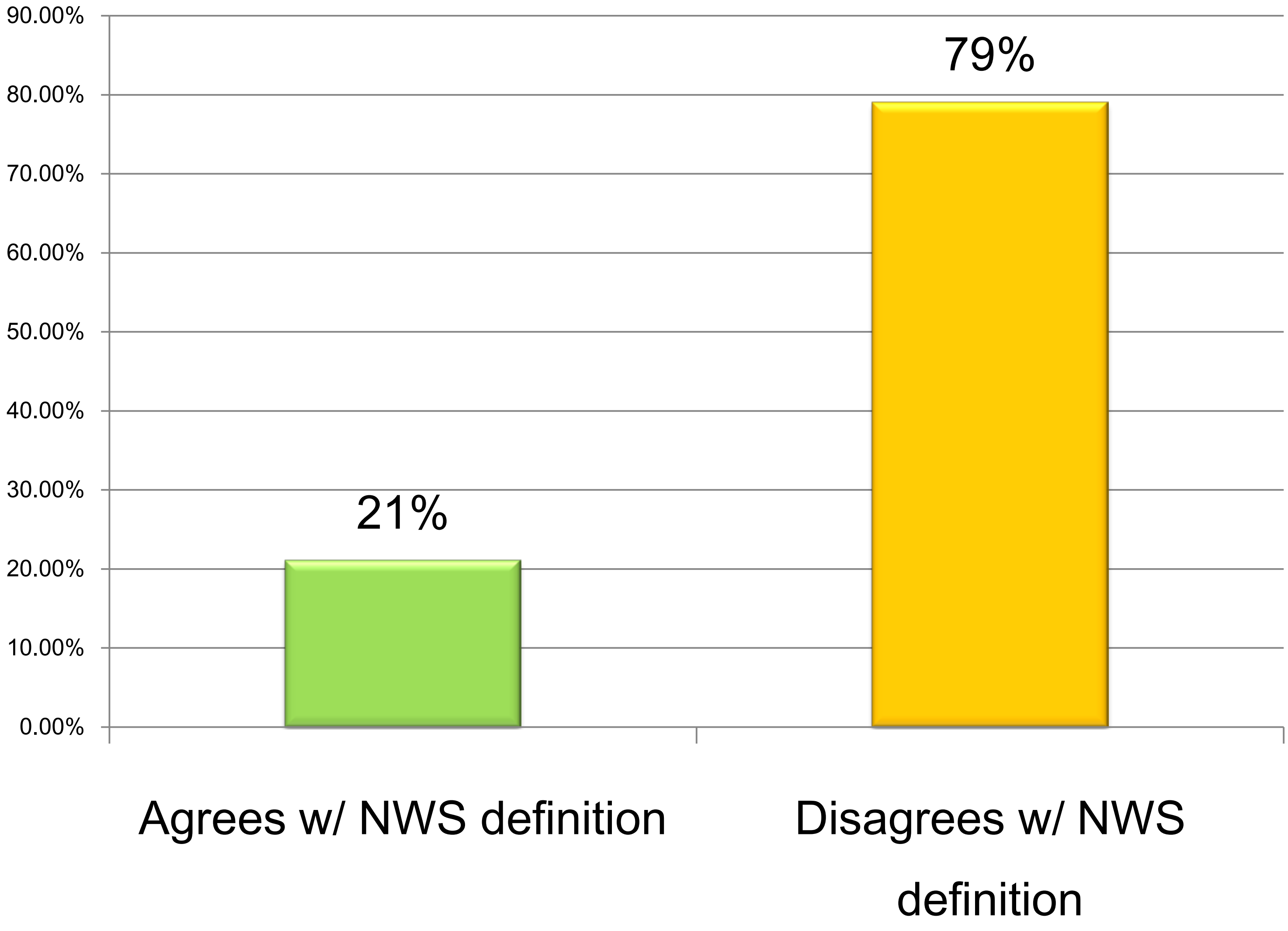
# Watch Definitions: Examples

- I think the watch is the more dangerous one
- Same as a warning
- When the TV flashes yellow
- They put it up on the TV and tell you what time it will be in your area and when to take shelter
- They feel like there's one [tornado] in our vicinity
- A  tornado is on the ground near your house
- Tornado was been sighted in my area

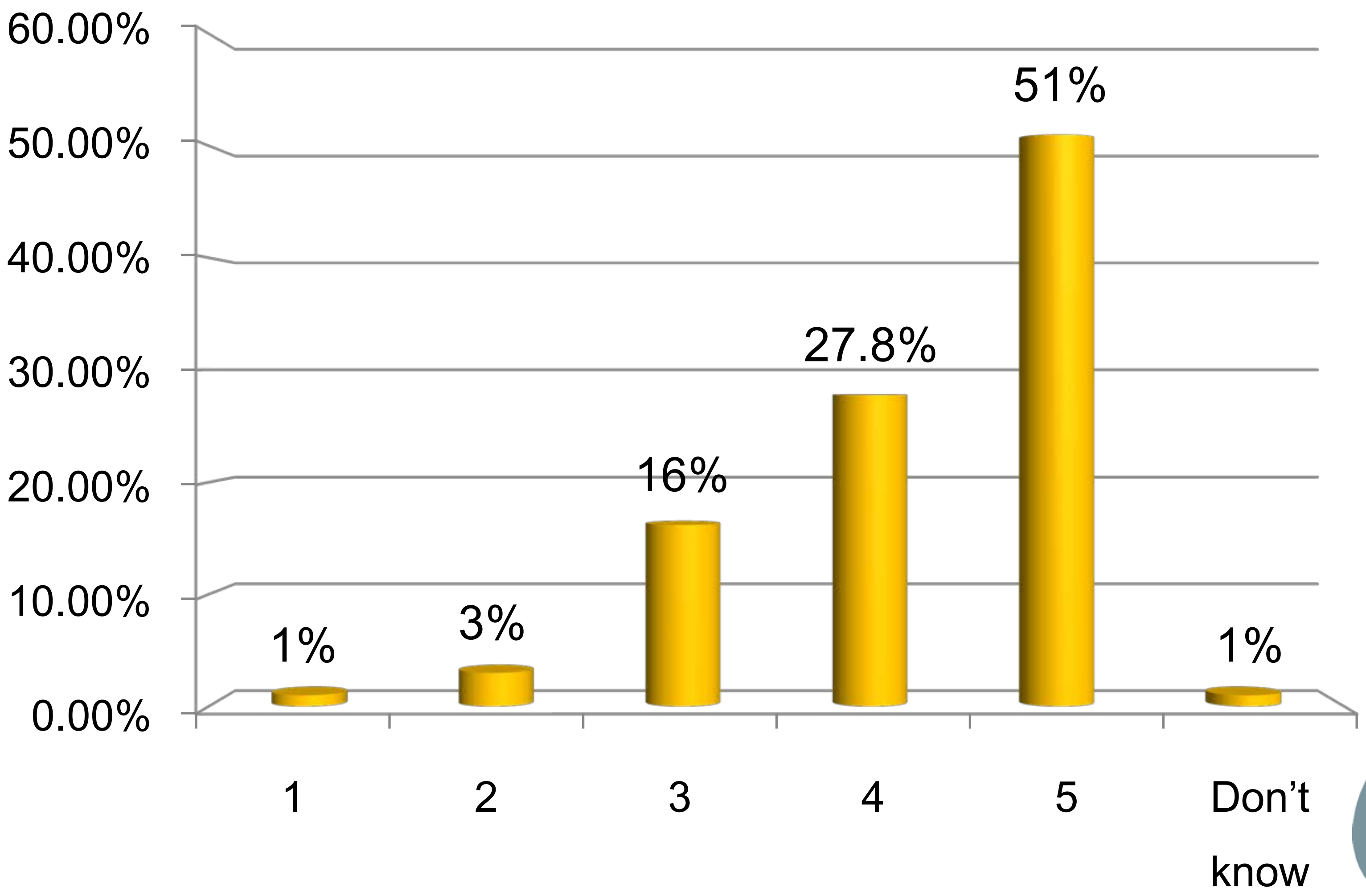
# Warning Definition



# False Alarm Definition



## In your opinion, how trustworthy are the weather forecasts provided in your region? (1 being "not trustworthy at all" to 5 "very trustworthy")



# Next Steps

- Continue CATI Survey; expand sample size and geographic areas

- Develop predictive models on protective action:
  - Binary logistic model to predict protective action following severe weather warning or a hazard event
  - Estimate the probability that the dependent variable will assume a certain value (e.g., take protective action or not) based on a number of independent variables

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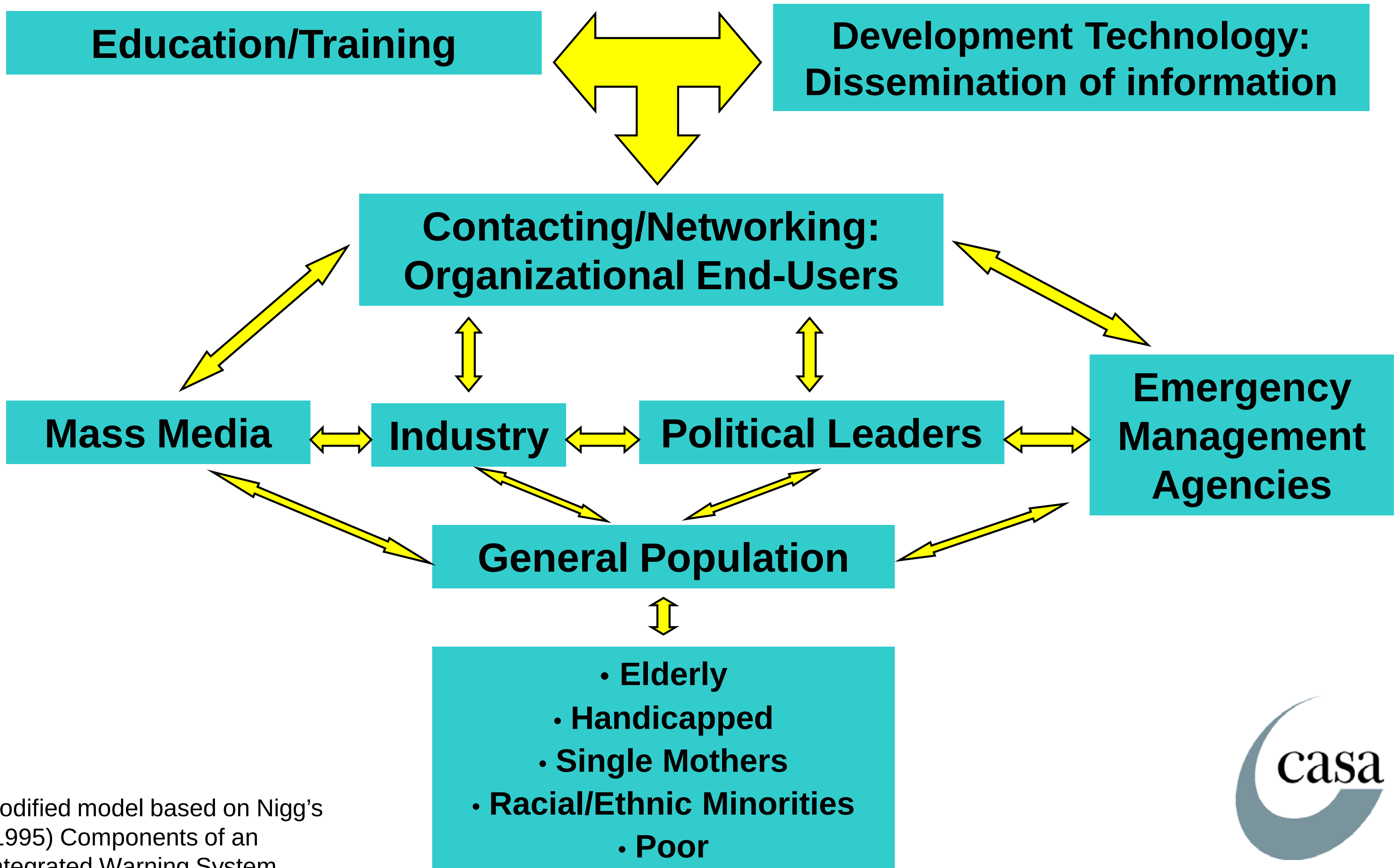
# Technology and Substantive Knowledge

- Technology matters, but what really matters is the **application of the substantive knowledge** that we generate regarding how individuals respond (or not) to severe weather events and how can we **improve** their **response** in order to minimize the devastating impacts associated with these events

- **Develop an integrated/holistic model to communicate risk and warnings, which takes into account:**
  - The contributions of different disciplines: an interdisciplinary approach
  - The role of new and emerging technology
  - The role of the media
  - And, the changing socio-economic and demographic characteristics of the general population

# A Model for Communicating Hazard Risk and Warnings*




*Modified model based on Nigg's (1995) Components of an Integrated Warning System.

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# Concluding Remarks

- We must actively engage end-users in identifying their risks, disaster planning and management, development of technology, and the communication process

- We must respond to the needs, interests, and the limitations that end-users confront, if we are to achieve the desired outcome:
  - Reduction in the loss of life, injuries, and damage to property

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# Questions from the Field


http://www.mind-mapping.co.uk/assets/examples/MM---Questions.gif