

Tornado Tales: Version 1 Reference Report

Taylor Maciag^{1,2}, Justin Sharpe^{1,2}, Makenzie Krocak², Kodi Berry², and Randy Pepler¹

¹Cooperative Institute for Severe and High-Impact Weather Research and Operations, The University of Oklahoma, Norman, Oklahoma

²NOAA/OAR/National Severe Storms Laboratory, Norman, Oklahoma

ABSTRACT

On average, the United States experiences more than 1,000 tornadoes each year, yet relatively few of them are studied in detail. Fewer yet are studied from a social science perspective, where data are collected about the information used to make decisions during these short-fuse, highly impactful events. In an effort to collect data about individual experiences during tornado events, the University of Oklahoma and the NOAA National Severe Storms Laboratory developed the Tornado Tales survey, a post-tornado-event survey where people can report their tornado experiences anonymously and asynchronously. The initial version of this survey was in the field from February 1, 2023 to May 7, 2024 and collected 234 responses. Initial results show that most people who responded to the survey received a tornado warning, generally from automated phone notifications, sirens, social media, and television. Most respondents also reported receiving a watch and sheltering after receiving the tornado warning. Future iterations of this survey will include questions about efficacy, weather salience, risk perceptions, and more open ended questions. Long-term research goals will evaluate the evolution of forecast and warning sources and differences in warning reception, understanding, and response across segments of the population. Understanding how people use tornado forecasts and products during real events is a key step to ensuring high-quality, equitable services.

1. Introduction

a. Background

Each year, over 1,000 tornadoes affect communities across the United States, but very few of those individual tornadoes are studied. When they are, most of the data collected are physical-science based, like radar observations of the parent thunderstorm or near-surface wind measurements, for example. Very little (if any) data are collected about what individuals experienced immediately before and during tornado events. As such, very little is known about how individuals receive, interpret, and respond to tornado forecasts and products. No generalizable information exists on tornado warning response after real-world events.

To more fully evaluate the tornado information environment, researchers need data from individuals who experience these events, including information about reception, decision making, and behavioral response. While efforts to study tornado events from a social science perspective via post-event interviews are increasing, it is unreasonable to expect every event to be evaluated in this way. Furthermore, some individuals may be unable or unwilling to speak to researchers in person, preferring a more anonymous or asynchronous form of data collection. To this end, a team of physical and social science researchers from the NOAA National Severe Storms Laboratory (NSSL) and the University of Oklahoma Cooperative Institute for Severe and High-Impact Weather Research and Operations (CIWRO) developed a [web-based survey](#) that individuals can take after they were in or near a tornadic storm (or a storm that had the potential to be tornadic). These initial questions were tested during fieldwork data collection with tornado-impacted communities following the Quad State (MO, AR, KY, TN) tornadoes of December 2021, the Idabel and Durant, OK tornadoes of November 2022, and Rolling Fork and Amory, MS tornadoes of March 2023. This initial work enabled researchers to verify the usability and understanding of questions by the public before they were implemented in the survey.

The goal of this survey is to collect information about an individual's experience with tornado forecast and warning information. For example, from where did they get forecast and warning information? Did they receive a watch or warning? If so, how? Did they take action in response to the watch or warning? If so, what did they do? These questions can be evaluated in aggregate or across multiple dimensions, like geographic area, time of year, demographic characteristics, etc. The survey instrument can be found [at this link](#). The data from this survey will be used to contextualize individual experiences and evaluate how information is propagating from the National Weather Service (NWS) to communities, allowing for more tailored, equitable, and effective

messaging. With sufficient response numbers, individual events can be evaluated on a community level, enabling NWS offices to customize messaging to their communities. Beyond the scientific and communication benefits for NOAA and the NWS, individuals may benefit from sharing their experiences with the agency. Only the date, time, and zip code of the tornado event is required, allowing users the ability to share as much or as little information about their experience as they wish to. The full survey takes 5-10 minutes to complete and the instrument has been approved by the Office of Management and Budget (OMB) and by the University of Oklahoma Institutional Review Board (IRB) to ensure compliance with human subjects research ethics and the Paperwork Reduction Act.

b. Sampling

The Tornado Tales survey is 100% voluntary, meaning recruitment consists of offering the survey link as a way for participants to share their experience with no expectation of participation. Additionally, there is no compensation provided for filling out the survey. Recruitment for version 1.0 primarily consisted of media exposure (with broadcast meteorologist partners and on social media). Future recruitment strategies will also emphasize in-person recruitment using business cards with the [link to the survey](#) (and a QR code) on them. Version 1.0 was in the field from February 1, 2023 to May 7, 2024.

c. Data analysis

All data collected via the Tornado Tales survey tool are completely anonymous. If a participant shares personal information (like addresses) in the open-ended question boxes, researchers trained in human subjects research remove those pieces of information, creating a completely anonymous final data set.

Each year, an annual report of survey responses will be created and posted to the NSSL Social Science webpage (<https://www.nssl.noaa.gov/research/social/>) in the late summer (July and August) summarizing how people responded to each question. Long-term research using this dataset will evaluate the evolution of forecast and warning sources, differences in event notification timeframes, and differences in warning reception, understanding, and response across segments of the population. Understanding how people are using NWS forecasts and products during real events is a key step to ensuring high-quality, equitable services.

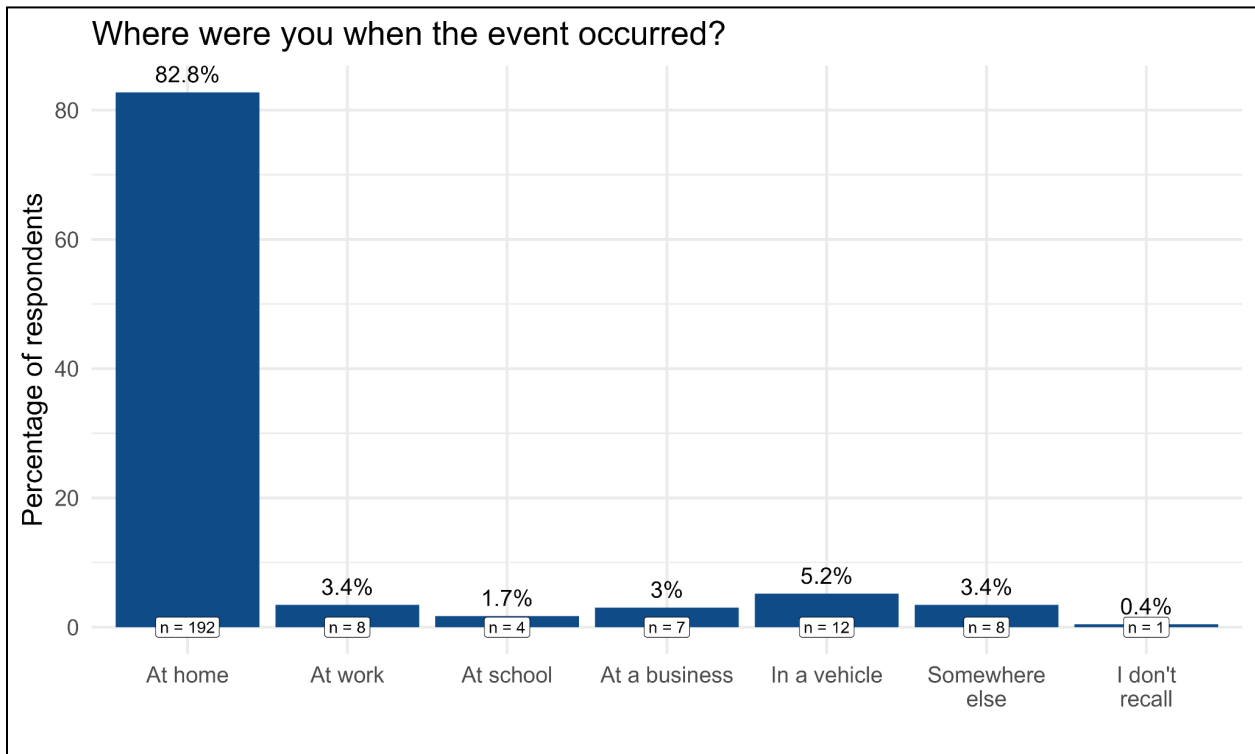
2. Survey Instrument and Frequency Report

This section provides a reproduction of the Tornado Tales version 1.0 survey instrument

with frequencies for the questions that elicited numeric responses, and general themes for open ended responses [shown in blue].

loc: Where were you when the event occurred?

1. At home [82.8%, n=192]
2. At work [3.4%, n=8]
3. At school [1.7%, n=4]
4. At a business (such as a store or restaurant) [3.0%, n=7]
5. In a vehicle (such as a car, truck, or bus) [5.2%, n=12]
6. **loc_spec:** Somewhere else (please specify, VERBATIM) [3.4%, n=8]
 - o Examples: Conference center, parking garage, church, underground tornado shelter, someone else's house, work party, etc.
7. I don't recall [0.4%, n=1]

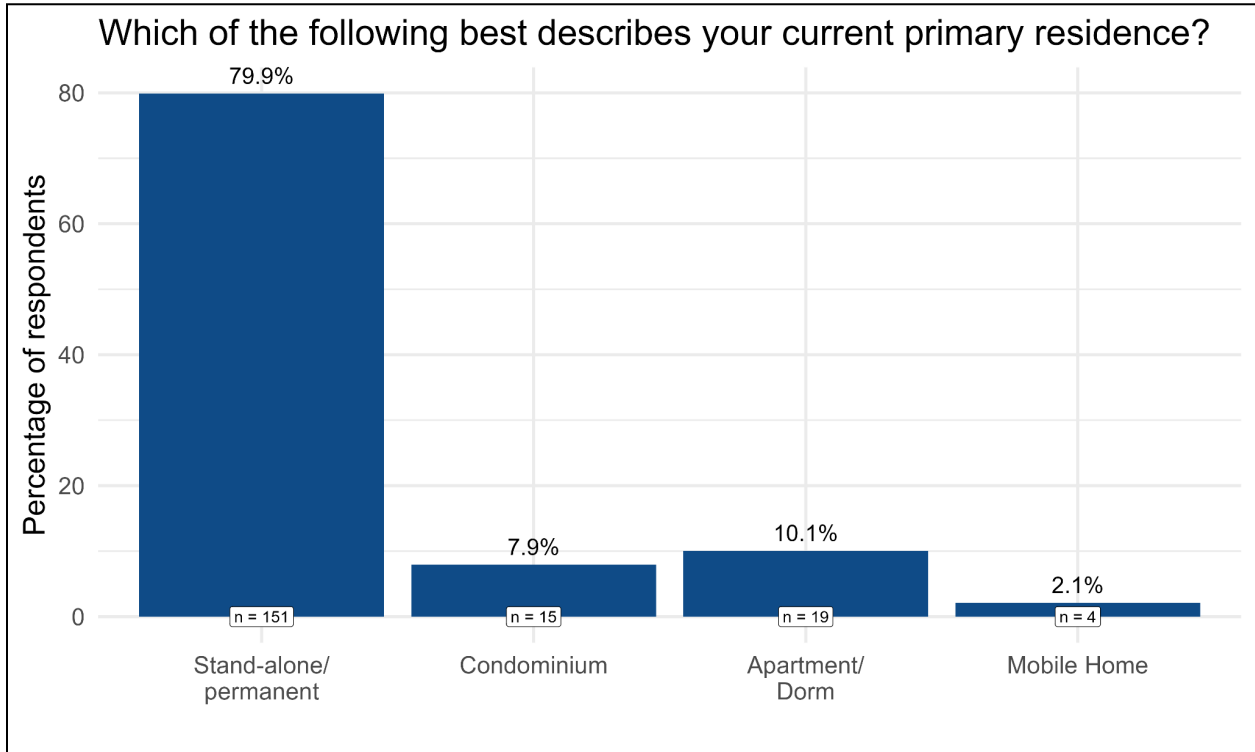


[SHOW IF **loc** == 1]

home: Which of the following categories best describes your current primary residence?

1. Stand-alone (detached) permanent structure such as a house [79.9%, n=151]
2. Condominium, town-house, or duplex that is attached to another structure [7.9%, n=15]
3. Apartment or dormitory room that is part of a larger residential complex [10.1%, n=19]

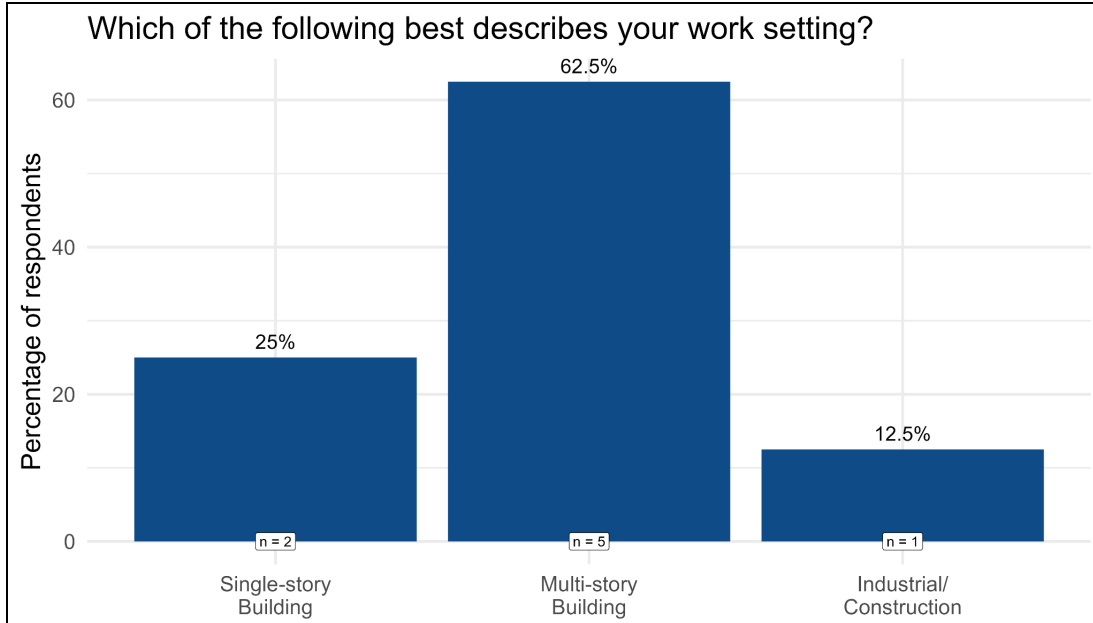
4. Mobile home (whether placed on a permanent foundation or not) [2.1%, n=4]
5. Boat, boathouse, ship, dock, or other floating structure [0%, n=0]
6. **home_spec**: Other type (please specify, VERBATIM) [0%, n=0]



[SHOW IF loc == 2]

work: Which of the following categories best describes your work setting?

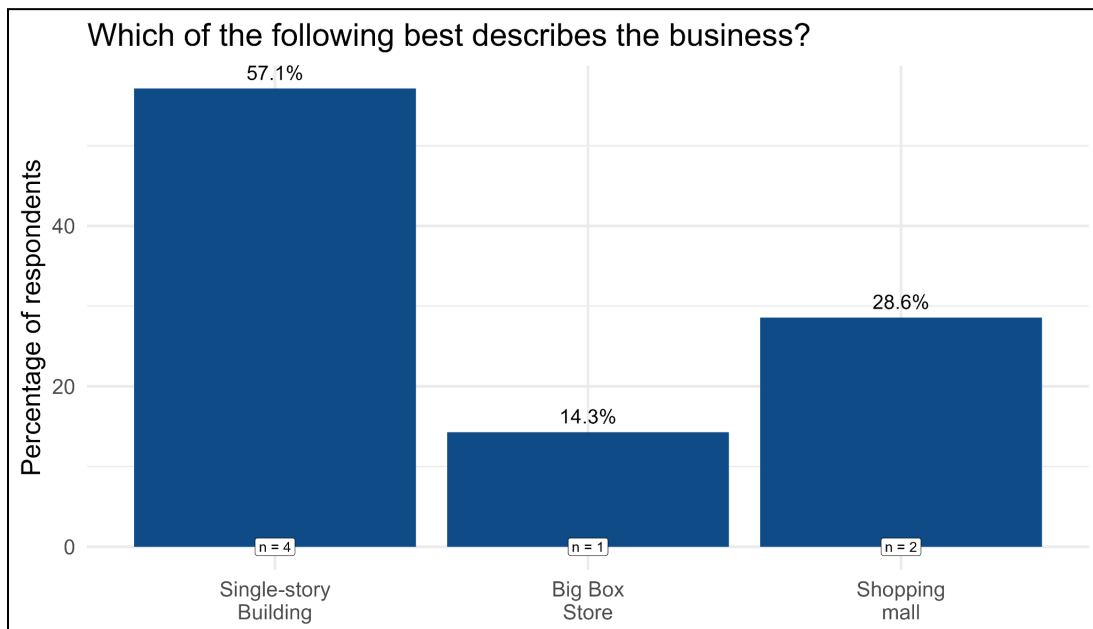
1. Single-story Building [25.0%, n=2]
2. Multi-story Building [62.5%, n=5]
3. Big Box Store, e.g., Lowes, Home Depot, Walmart [0%, n=0]
4. Shopping mall [0%, n=0]
5. Industrial or Construction setting [12.5%, n=1]
6. **work_spec**: Other type (please specify, VERBATIM) [0%, n=0]



[SHOW IF loc == 4]

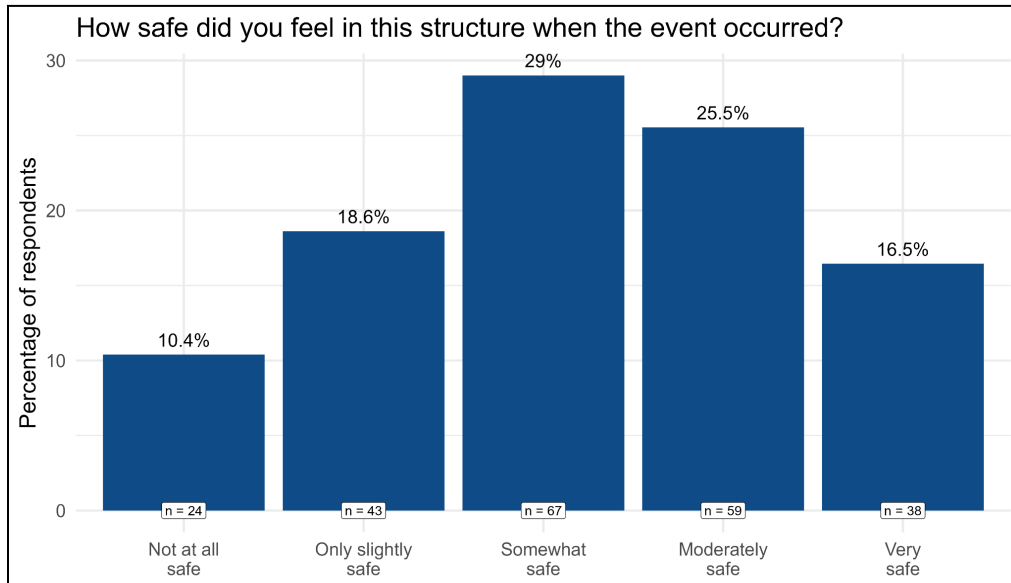
business: Which of the following categories best describes the business?

1. Single-story Building [57.1%, n=4]
2. Multi-story Building [0%, n=0]
3. Big Box Store, e.g., Lowes, Home Depot, Walmart [14.3%, n=1]
4. Shopping mall [28.6%, n=2]
5. **bus_spec:** Other type (please specify, VERBATIM) [0%, n=0]



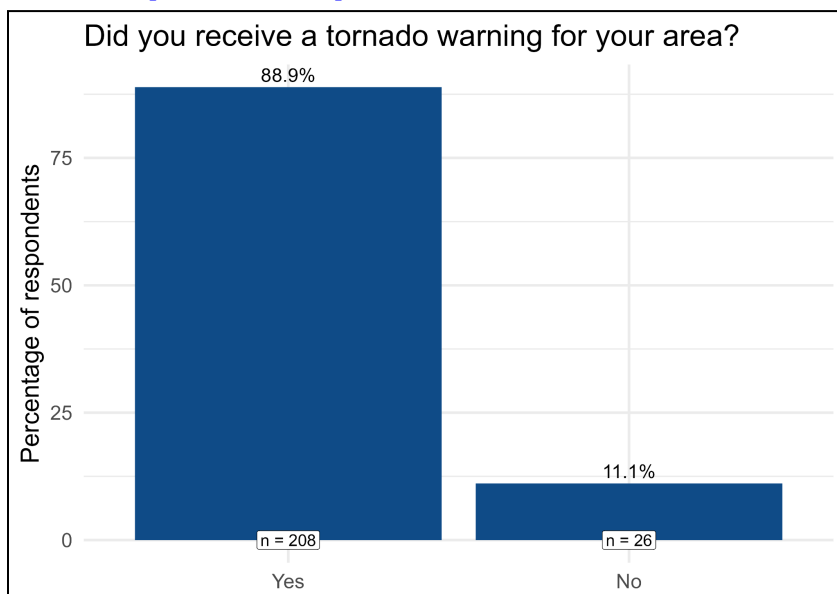
struc_safe: How safe did you feel in this structure when the event occurred?

1. Not at all safe [10.4%, n=24]
2. Only slightly safe [18.6%, n=43]
3. Somewhat safe [29.0%, n=67]
4. Moderately safe [25.5%, n=59]
5. Very safe [16.5%, n=38]



torn_warn: A Tornado Warning is issued by the National Weather Service when a tornado is imminent. Did you receive a tornado warning for your area? (select one option)

1. Yes [88.9%, n=208]
2. No [11.1%, n=26]



How did you learn about the tornado warning? Please select all that apply. n=205

warn_how_broad: Broadcast Radio [4.9%, n=10]

warn_how_wxrad: Weather Radio (National Weather Service radio) [22.4%, n=46]

warn_how_tv: Television [39.5%, n=81]

warn_how_siren: Siren or other alarm [44.9%, n=92]

warn_how_int: Internet [25.4%, n=52]

warn_how_soc: Social media such as Twitter or Facebook [41.0%, n=84]

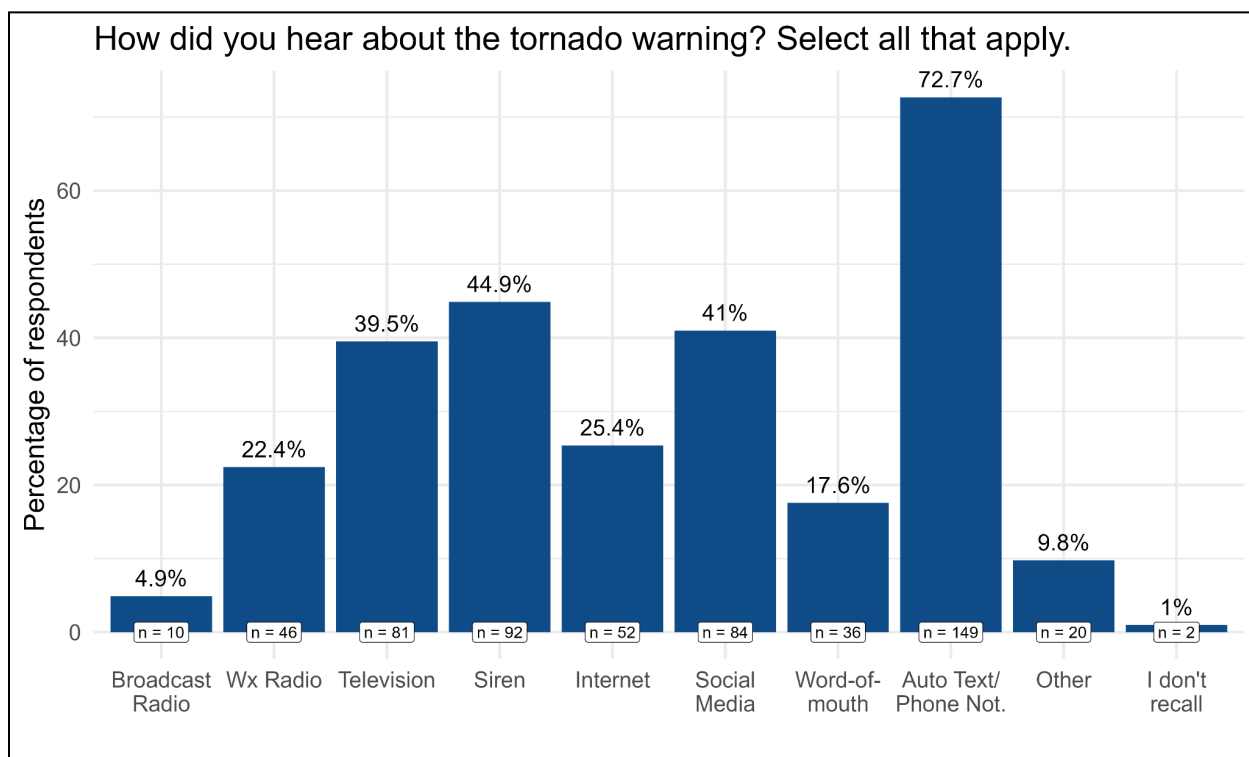
warn_how_wom: Word-of-mouth (including telephone or text messages, email, etc.)
from family, friends, neighbors, employers, co-workers, etc. [17.6%, n=36]

warn_how_phone: Automated text or phone notifications [72.7%, n=149]

warn_how_other: Other source (Please specify, **warn_how_oth_spec:** VERBATIM)
[9.8%, n=20]

- Examples: phone app (weather forecast, radar, broadcast media), YouTube livestream, HAM radio, Amazon Alexa, etc.

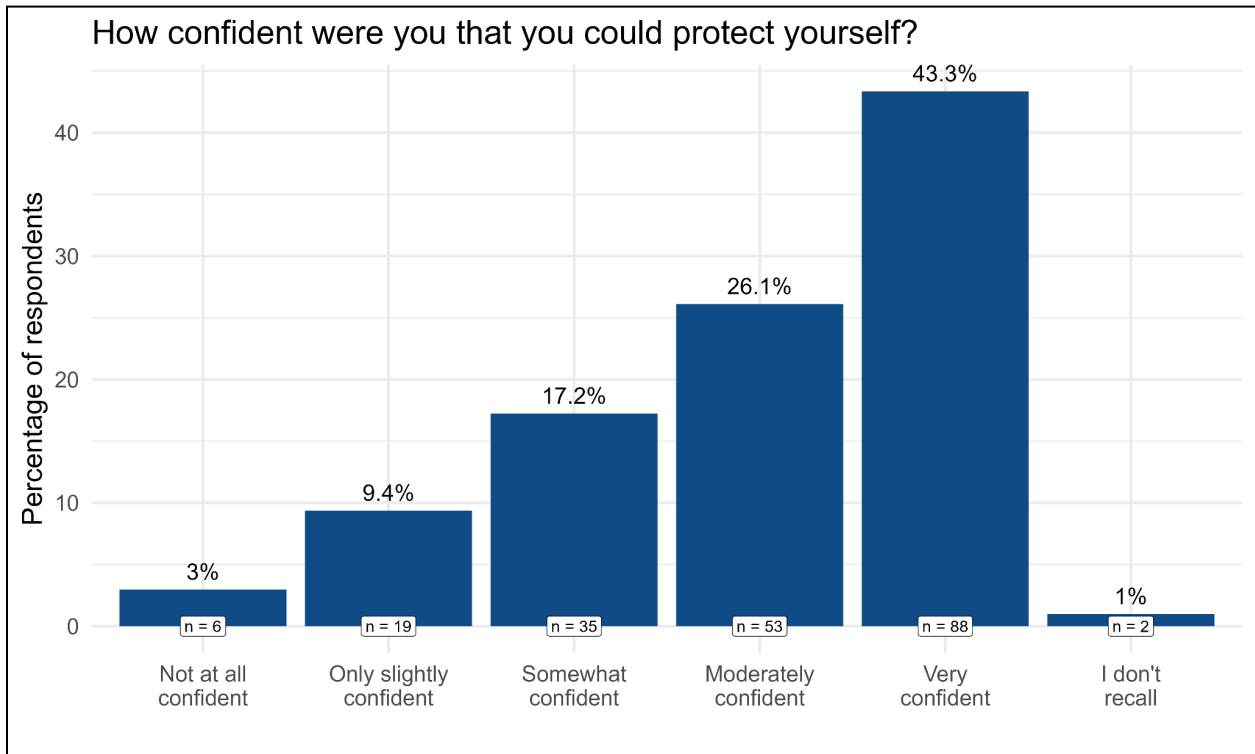
warn_how_dk: I don't recall [1.0%, n=2]



warn_act_conf: When you received the tornado warning, how confident were you that you could take action to protect yourself?

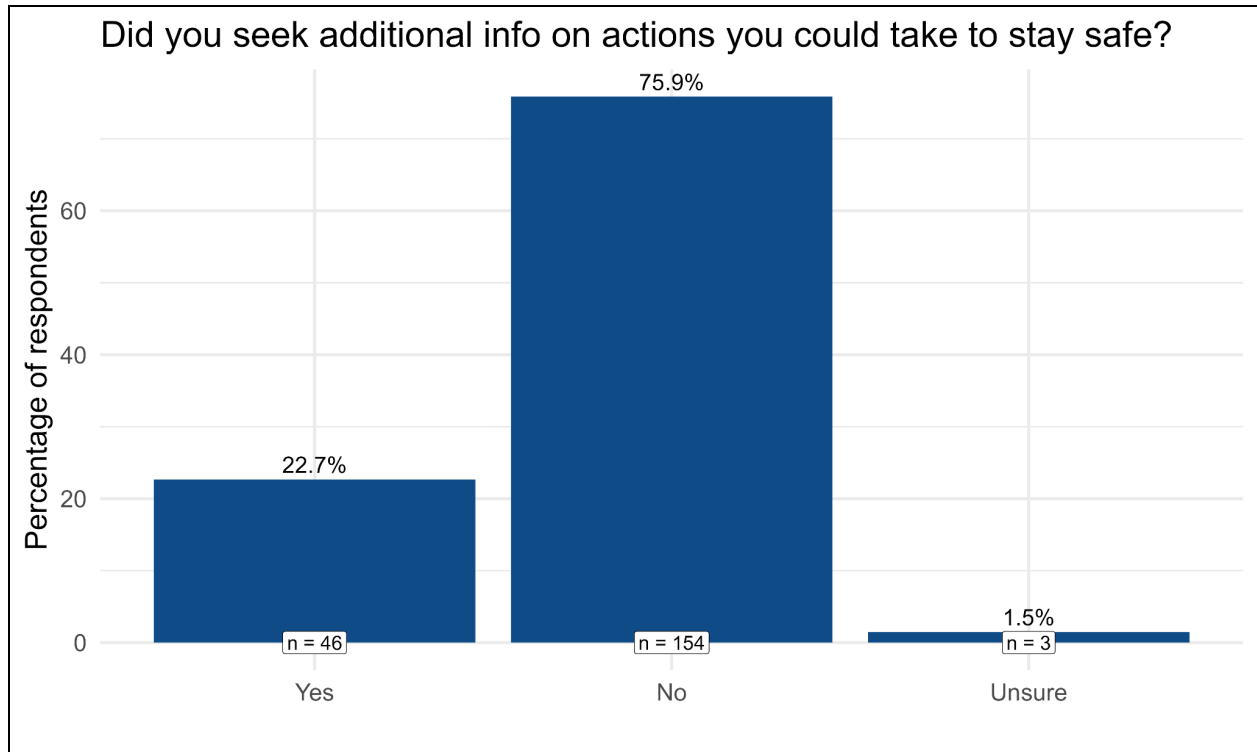
1. Not at all confident [3.0%, n=6]
2. Only slightly confident [9.4%, n=19]

3. Somewhat confident [17.2%, n=35]
4. Moderately confident [26.1%, n=53]
5. Very confident [43.3%, n=88]
6. I don't recall [1.0%, n=2]



warn_mill: When you received the tornado warning, did you need to seek additional information on actions you could take to stay safe?

1. Yes [22.7%, n=46]
2. No [75.9%, n=154]
3. Unsure [1.5%, n=3]



What did you do when you got the tornado warning? (select all that apply) **n=202**

warn_do_noth: Nothing; continued my daily activities [4.0%, n=8]

warn_do_mon: Monitored the situation, but did not move to shelter [25.7%, n=52]

warn_do_build: Moved to the most sheltered part of the building, but did not leave the building [50.0%, n=101]

warn_do_fam: Moved family or friends to the most sheltered part of the building, but did not leave the building [27.7%, n=56]

warn_do_shelt: Moved to a specially constructed storm shelter in the building [7.4%, n=15]

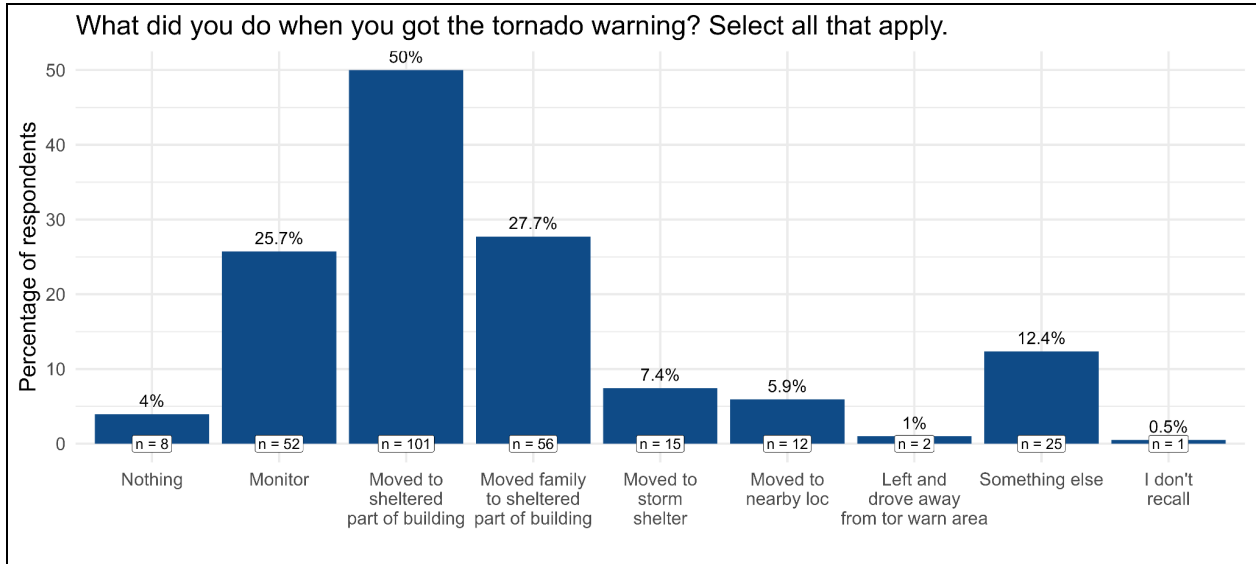
warn_do_near: Moved to a nearby location or building that provided safer shelter [5.9%, n=12]

warn_do_left: Left the building and drove away from the tornado warning area [1.0%, n=2]

warn_do_oth: Something else (please specify, **warn_do_oth_spec**: VERBATIM) [12.4%, n=25]

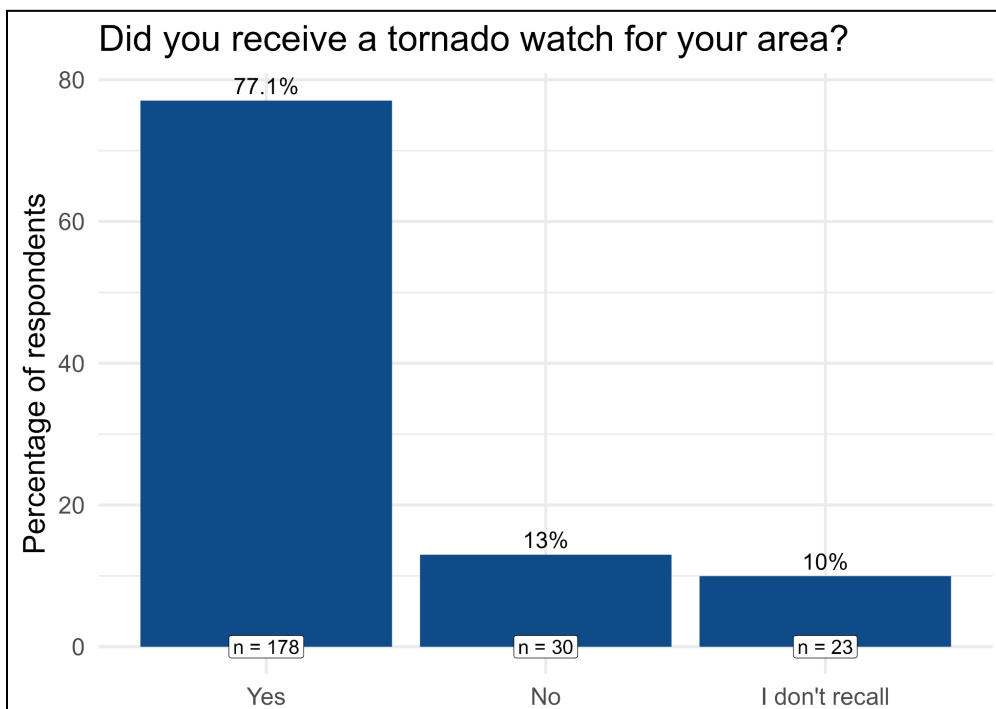
- Examples: observed the tornado, moved pets to shelter/secure pets/livestock, looked outside, monitored while driving, moved to the basement, alerted family/friends nearby, already in storm shelter, watched TV and radar apps, moved family to nearby location, etc.

warn_do_dk: I don't recall [0.5%, n=1]



torn_watch: A Tornado Watch is issued by the National Weather Service when tornadoes are possible in and near the watch area. Did you receive a tornado watch for your area?

1. Yes [77.1%, n=178]
2. No [13.0%, n=30]
3. I don't recall [10.0%, n=23]



How did you learn about the tornado watch? (check all that apply) n=175

watch_how_broad: Broadcast Radio [6.9%, n=12]

watch_how_wxrad: Weather Radio (National Weather Service radio) [17.7%, n=31]

watch_how_tv: Television [39.4%, n=69]

watch_how_siren: Siren or other alarm [9.7%, n=17]

watch_how_int: Internet [37.7%, n=66]

watch_how_soc: Social media such as Twitter or Facebook [48.7%, n=87]

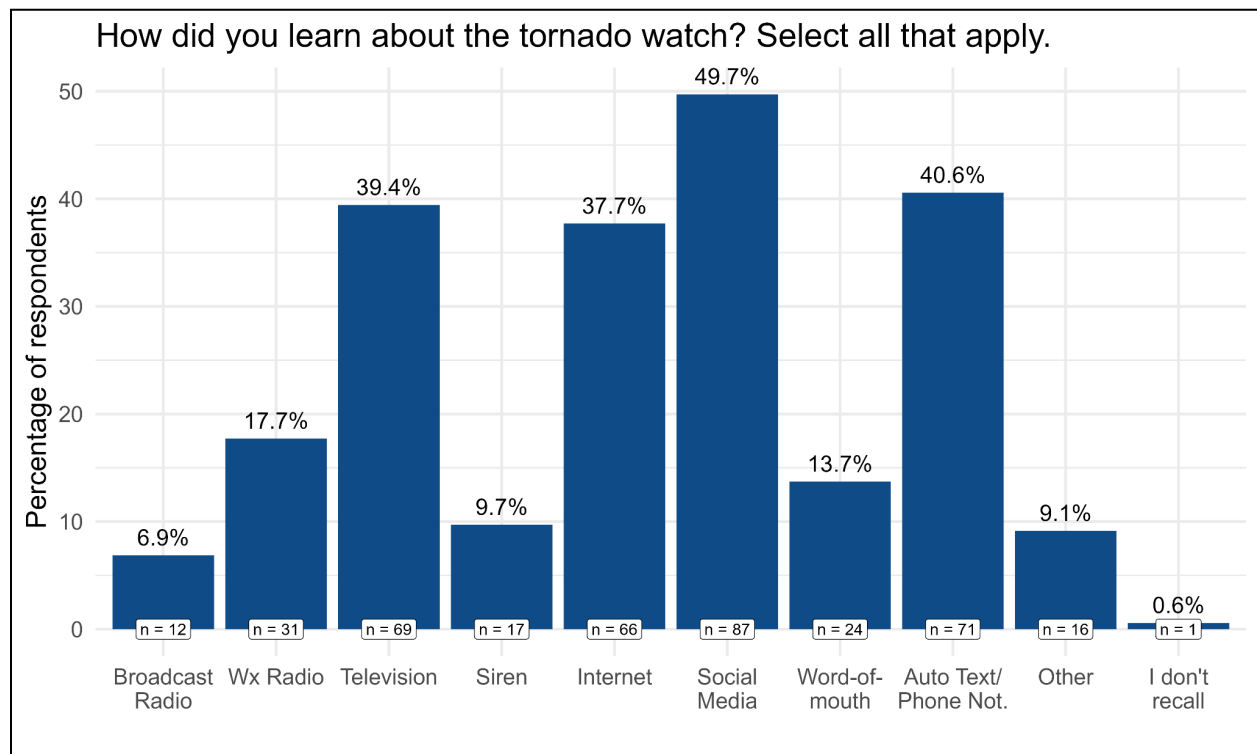
watch_how_wom: Word-of-mouth (including telephone or text messages, email, etc.) from family, friends, neighbors, employers, co-workers, etc. [13.7%, n=24]

watch_how_phone: Automated text or phone notifications [40.6%, n=71]

watch_how_other: Other source (Please specify, **watch_how_oth_spec:** VERBATIM) [9.1%, n=16]

- Examples: phone app (weather forecast, news, broadcast media, radar), Amazon Alexa, storm chasers' media, home security system, etc.

watch_how_dk: I don't recall [0.6%, n=1]



What did you do when you got the tornado watch? n=176

watch_do_noth: Nothing; continued my daily activities [18.2%, n=32]

watch_do_em: Checked emergency supplies [16.5%, n=29]

watch_do_buy: Bought emergency supplies [1.1%, n=2]

watch_do_wxrad: Made sure NOAA radio was on and charged/plugged in [16.5%, n=29]

watch_do_tv: Had local TV News/Weather on [50.0%, n=88]

watch_do_rad: Had local radio News/Weather on [13.6%, n=24]

watch_do_app: Checked my weather App on my phone frequently (NOAA weather radio, etc.) [51.1%, n=90]

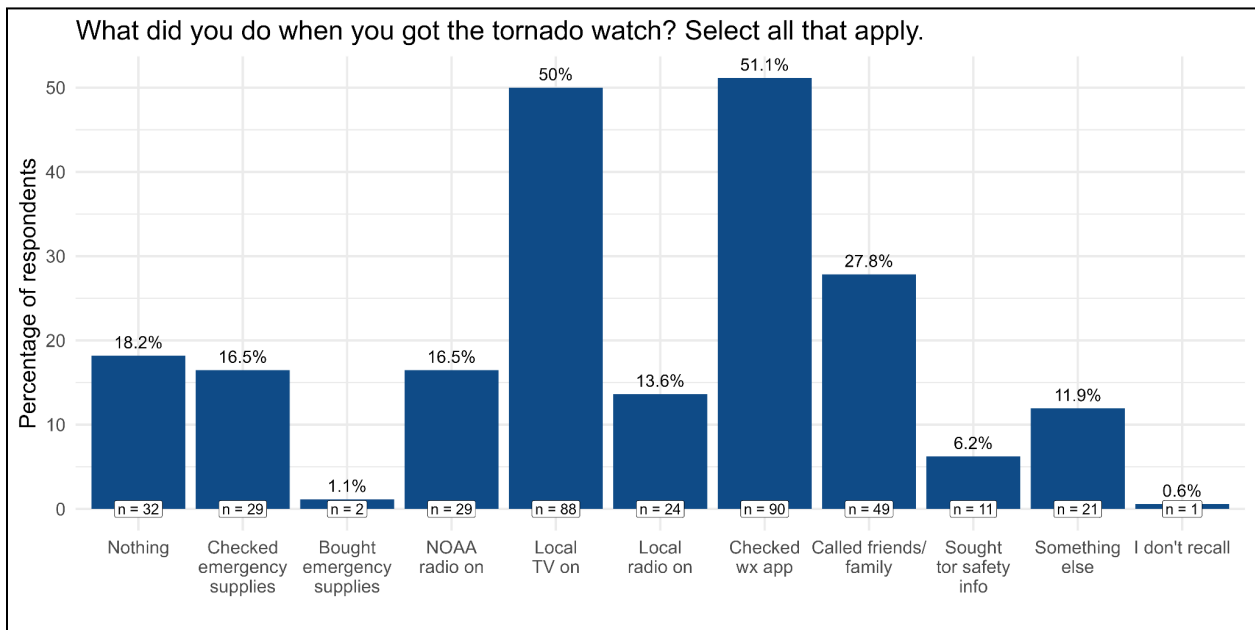
watch_do_wom: Called friends and family nearby to warn them [27.8%, n=49]

watch_do_search: Sought information on tornado safety [6.2%, n=11]

watch_do_other: Something else (please specify, **watch_do_oth_spec:** VERBATIM) [11.9%, n=21]

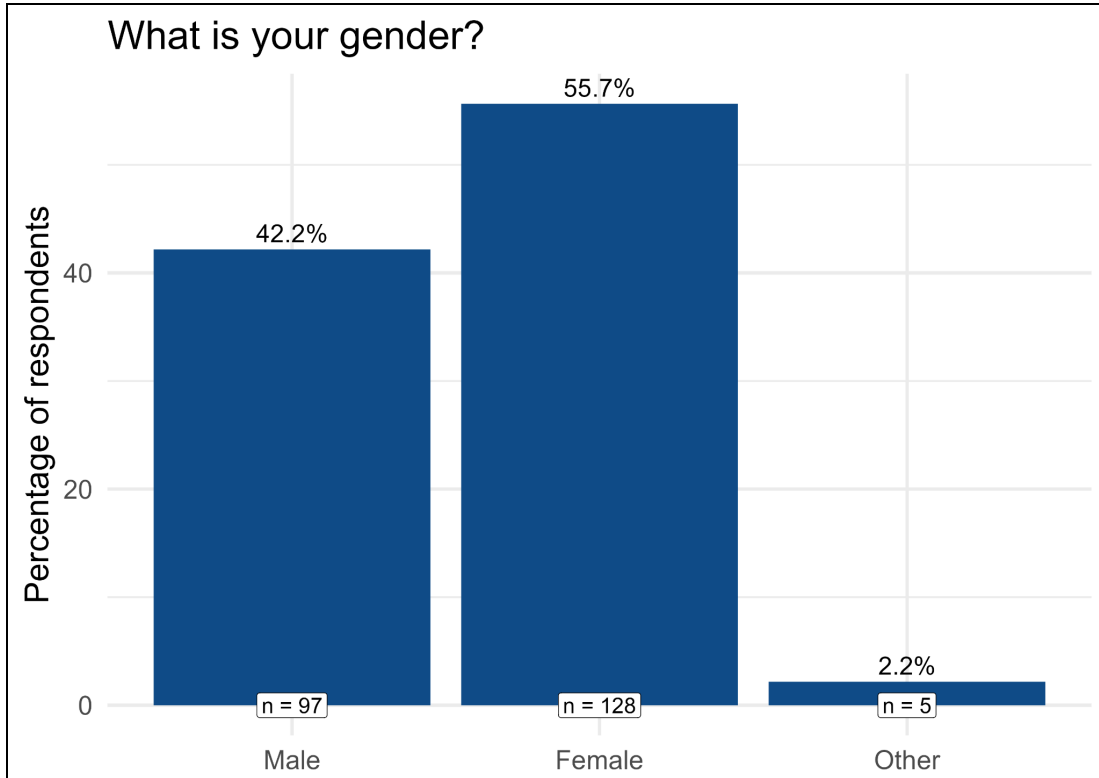
- Examples: gathered supplies into car, moved to a safer location, cleared out closet, shared weather information on social media, watched storm chaser updates, checked SPC and NWS websites/social media, brought in/secured lose items outdoors, monitored radar, etc.

watch_do_dk: I don't recall [0.6%, n=1]

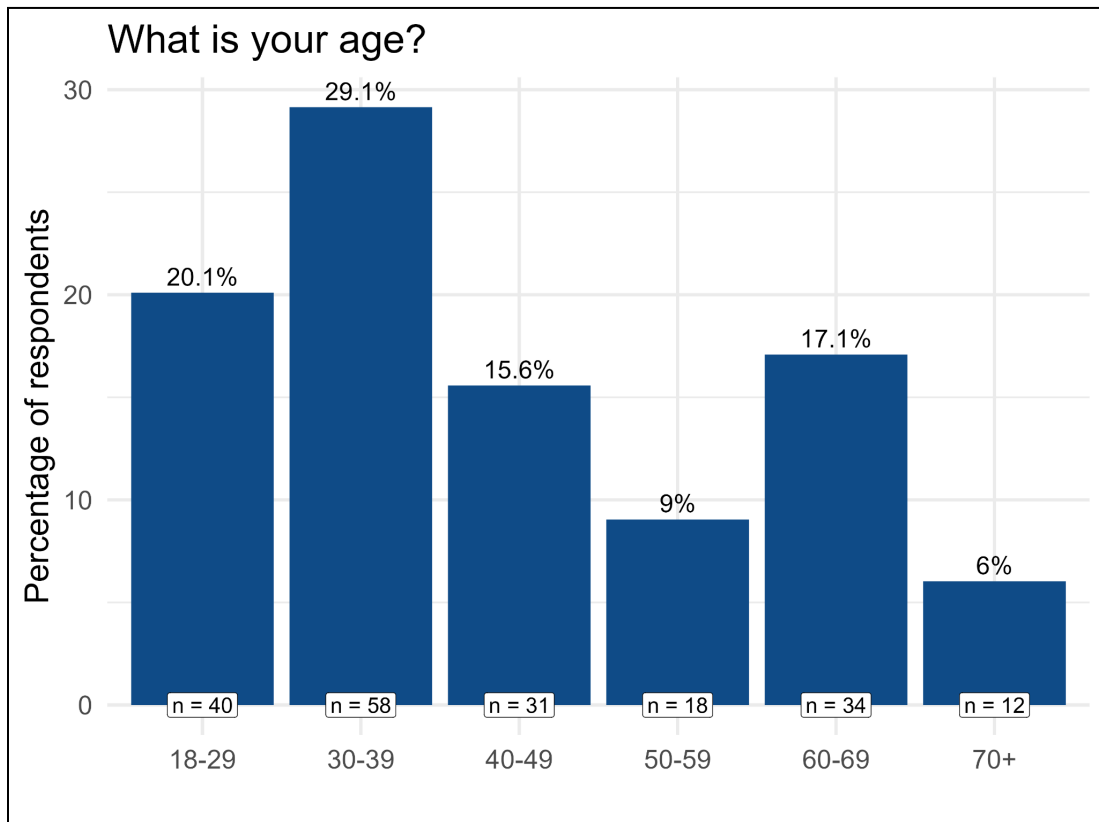


gend: What is your gender?

1. Male [42.2%, n=97]
2. Female [55.7%, n=128]
3. Other/prefer not to answer [2.2%, n=5]



age: What is your age? [VERBATIM]



other_info: What other information would you like us to know about this event? (This can be anything you want to share about your experience with this tornado)
[VERBATIM]

Actions Taken	Count
Monitor information sources (e.g., local television, NWS sources, social media, etc.)	52
Move to safer shelter	44
Gather family/pets	12
Talked on the phone with family/friends	11
Prep/clean shelter	5
Collect emergency supplies	3
Left work early	2

Environmental Cues	Count
Saw rotation/funnel cloud/tornado	10
Heard tornado/high wind	8
Saw wall cloud	4
Strong winds	3
Large hail	3
Sideways rain/heavy rain	2

Other Observations	Count
Damage to home or nearby	21
Lost power	20
Heard sirens	9

Didn't hear sirens	9
Storm anxiety	9
Received alerts from phone	7
Little time to shelter	5
Weather radio went off	4

3. Summary of Initial Results

A total of 234 responses were collected with this iteration of the survey. Of those 234, 154 of them came from three events: December 9, 2023 (n=114) in the Nashville, TN area, April 19, 2023 (n=29) in central and southern Oklahoma, and March 31, 2023 (n=11) across numerous states in the eastern U.S. It is important to note the relatively small number of events captured when considering the implications of these results.

a. Location of respondents when tornadoes impacted them

The majority of respondents (83%, n=192) reported being at home when the event occurred. Another 5% (n=12) were in a vehicle at the time of the event and 3% (n=8) were at work. There is also a verbatim box labeled "other" to try and capture other places that people were. Some of those answers included: at a conference center, parking garage, in church, in an underground tornado shelter, someone else's house, work party, etc., and these responses made up 3% (n=8) overall.

b. Safety of the structure when the event occurred

Most respondents reported feeling somewhat safe to very safe in the structure they were located in during the event. Combined, these categories made up 71% of responses, leaving 29% who reported either feeling slightly safe or not at all safe. As reported in the prior section, the majority (83%) of respondents were at home when the event occurred. Being at home is generally more likely to create a feeling of safety (Ash 2017), and being at home likely means that respondents would have a clearer idea of where their safe space is (e.g., bathroom, interior closet or hallway on lower floors). This may have had an impact on how respondents felt about their level of safety. Furthermore, 79% (n=151) were in stand-alone residential structures, which tend to fare better when tornadoes occur. Only 10% (n=14) of the sample were in apartments and just 2% (n=4) were in mobile or manufactured housing.

c. Tornado Warnings

Respondents were also asked if they received a tornado warning for their area. The survey instrument defines a NWS tornado warning as being issued “when a tornado is imminent” (NOAA 2024) for clarity. Across the sample, close to nine out of ten respondents reported receiving a tornado warning [89% (n=208)]. While around 11% of respondents said that they did not receive a tornado warning, we did not inquire further about why they did not receive a warning.

Next, we asked respondents to indicate how they received the warning. A total of 205 respondents replied to this “check all that apply” question. The largest response was automated text or phone notifications, with 73% of respondents receiving a tornado warning in this manner. Another 45% were warned by a tornado siren, 41% by social media (such as Twitter, now X, and Facebook), and 40% from television. Twenty-five percent (25%) of respondents reported receiving warning information from the internet more broadly, while 22% reported receiving a warning from NOAA Weather radios. Eighteen percent (18%, n=36) of respondents reported receiving a tornado warning from word-of-mouth sources, including text messages, emails, etc. Those that checked “other” (10%) reported receiving a tornado warning from smart devices such as Amazon’s Alexa and from various phone applications. Finally, 5% received a warning from broadcast radio. It is interesting to note that people reported receiving tornado warnings from multiple sources, similar to other recent survey findings (e.g., Krocak et al. 2024, Mason et al. 2018, Vaghn et al. 2023).

The survey also asked what (if anything) participants did in response to the warning. This question also allowed survey takers to choose more than one answer. Of the 202 responses, 50% moved to the most sheltered part of the building, but did not leave the building. The next most popular response was moving family or friends to the most sheltered part of the building, but not leaving the building (28%, n=56). These responses are consistent with 82% of the sample being at home for the event, assuming they did not leave their homes. Seven percent (7%, n=15) reported that they moved to a specially constructed storm shelter in the building while 6% (n=12) reported leaving their location for a specially constructed shelter.

Lastly, 25% reported monitoring the situation. Open-ended responses to this question reported a wide range of actions, including observing the tornado, moving pets to shelter/securing pets/livestock, looking outside, monitoring while driving, moving to the basement, and alerting family/friends nearby.

d. Confidence in actions taken

There is often little time to process and confirm actions before needing to take them when a tornado warning has been issued. However, initial data show that 87% (n=176) of respondents reported feeling somewhat confident in the actions they took or better, with half of those reporting they felt very confident. Conversely, only 12% of respondents were slightly confident or not confident at all.

e. Tornado Watches

We also asked respondents whether they received a tornado watch for their area, defining the watch as when tornadoes are “possible in and near the watch area” (NOAA 2024). The percentage for those reporting they received a tornado watch was 77% (n=178), slightly lower than for that of a tornado warning (89%, n=208). This is not surprising, as there are generally more sources for receiving a warning than a watch (e.g., sirens, for example). However, this value is still relatively high, and only 13% (n=30) said that they did not receive a tornado watch at all, leaving 10% (n=23) uncertain or unable to recall if they received one.

Similar to the questions about tornado warnings, 175 respondents answered the question regarding all of the sources they used to receive a tornado watch. Forty-nine percent (49%, n=87) reported that they received information about the tornado watch from social media, such as Twitter (now X) or Facebook. Whereas 80% reported receiving a tornado warning from automated text or phone notifications, considerably less (41%, n=71) reported receiving a phone notification for a tornado watch. This was followed by television at 39% (n=69), the internet at 38% (n=66) and NOAA weather radio at 18% (n=31). Almost 10% (n=17) reported that they received a tornado watch via a siren or other alarm, which may be the result of differing definitions about what constitutes an alarm, or mixing up a tornado watch and a tornado warning. Furthermore, 9% (n=16) filled in a verbatim text box, sharing other sources of information about a tornado watch, including smartphone applications (weather forecast, news, broadcast media, radar), Amazon Alexa, storm chasers’ media and home security systems.

f. Other information shared by respondents

The last question prior to gathering demographic information asked whether respondents would like to share any other information about the event. This allowed respondents to tell their own version of events, sharing information the survey otherwise did not ask about and adding detail to their reports. Some people shared more information about the actions they took, with 52 respondents reporting that they talked with friends and family, cleared out or prepped shelters/safe spaces, collected

emergency supplies and left work early. Respondents also monitored the environment, including seeing rotation/funnel cloud/tornado (n=10) and hearing high winds (n=8).

Other responses reported damage to their home (n=20), loss of power (n=21) and hearing sirens (n=9) or not hearing sirens (n=9). Finally, some respondents (n=9) reported feeling storm anxiety.

This report summarizes the initial phases of developing and fielding a post-tornado-event survey for members of the public. The second iteration of this survey includes additional questions about risk perception, efficacy, information sources, and more open-ended questions. Collection of this data is vital to ensure NOAA is providing useful and actionable information during these short-fuse, impactful weather events.

4. References

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