

# Evaluating Lead Time Differences on Residents' Responses to a Tornado Warning

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## Abstract

Residents living in tornado prone regions of the country generally know what protective actions to take during a tornado warning. Still, unsafe decisions following recommendations often result in injuries and fatalities that may be avoidable. The present research investigated the various actions and preparations individuals living in a tornado prone area would take when presented with 1 hour, 15 minutes, and 2 minutes of lead time.

## Introduction

Technological advancements have provided meteorologists with the ability to predict tornados and severe weather with great accuracy, but research has not focused on how citizens interpret and respond to information about approaching tornadoes. As Dr. Kelvin Droegemeier suggested in his testimony to a U.S. Congress subcommittee in June 2013, the impact of increased lead time may be significantly limited if researchers do not understand what people currently do during their warning lead time.

Marshall / DeKalb EF-3 Tornado - April 24, 2010



source: srf.noaa.gov

This graphic shows a predicted path for a tornado with estimated lead times. This image is typical of what TV meteorologists provide citizens in potentially impacted areas.

## Background:

- **Lead time** is the time between when a tornado warning is issued and when the tornado arrives at a specific area.
- Hoekstra et al. (2011) survey of 136 National Weather Center visitors
  - Ideal lead time 33.5 minutes
- Minniear et al. (2010) survey of 1100 U.S. residents in multiple regions
  - Ideal lead time 18 minutes
- Actual average lead time: 13 minutes (noaa.gov)

## Key questions for study:

- What do participants think is the ideal lead time?
- Are there differences in actions between lead time scenarios?
- Are there differences in the knowledge on how to respond between age groups?

## Method

### Participants:

- 60 individuals from UAH and the surrounding community were interviewed. Participants lived in the Southeastern United States for at least 4 years.
- 30 younger adults (18-42)
    - 21 female, racially diverse
    - UAH undergraduate students
  - 30 older adults (60-75)
    - 20 female, racially diverse
    - Community residents recruited through posters around Huntsville, AL.

### Procedure:

Each participant was interviewed individually by two interviewers in a comfortable lab environment.

- Interviews ranged from 45-90 minutes.
- Structured interview format was primarily used, along with naturalistic scenarios about advice that would be given to another person with no prior tornado experience.
- Audio from the interview was recorded using a voice recorder.
- Interviews were transcribed and uploaded to MAXQDA qualitative data analysis software.
- Two independent scorers coded each participant's responses following a predetermined coding scheme.



The study's focus was on analyzing questions about different amounts of lead time and ideal lead time.

- "Imagine you knew that you had a 15 minute lead time for a specific tornado and you were at home. What would be the first thing you would do?"
- "Now imagine you knew that you had a 1 hour lead time for a specific tornado and you were at home. What would be the first thing you would do?"
- "Now suppose you only have two minutes of warning. What would you do first?"

Two coders independently identified the activities in these questions. They then compared responses to confirm good interrater reliability (at least .70). Then, experimenters used a card sort technique to identify categories in which these activities could be grouped. This categorization is shown in Table 1.

Table 1. Lead Time Categories Developed from Participant Responses

Main Category	Original Activities Talled
Seek Information	Seek Information, Identify/Assess
Primary Responsibilities	Alert Others, Pets
Immediate Actions	Praying, Covering Head, Stay in Car
Preparatory Actions	Preparatory Actions, Emergency Items, Sentimental Items, Leave the Area
Exterior Shelter	Find a Building, Overpass, Ditch
Interior Shelter	Shelter, Bathroom, Closet, Basement

## Results

Question 1: What is the ideal lead time for participants in different age groups?

Figure 1  
Average Ideal Lead Time

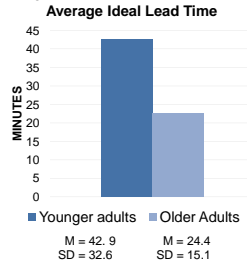
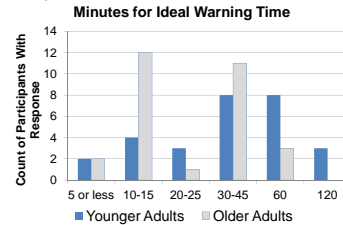


Figure 2  
Minutes for Ideal Warning Time



A t-test was conducted to compare the average ideal lead times reported by students and community members. Analysis found a significant difference in ideal lead times  $t(56)=2.782, p=.007, d=.69$ .

Chi Square analysis was conducted comparing the frequency of ideal lead times. Analysis failed to find a significant relationship between ideal lead time for students and members of the community  $\chi^2(5, N=58) = 10.47, p=.06$ .

Question 2: Are there differences in actions between lead time scenarios regardless of age?

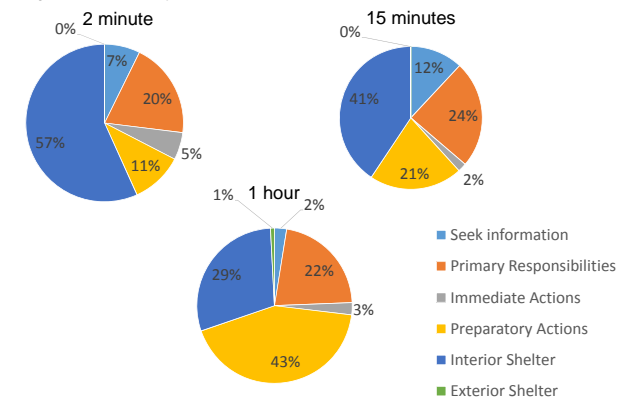
Chi square analysis was conducted to compare the frequency of responses for each of the six lead time categories.

Table 2

	2 minutes	15 minutes	1 hour
Seek Information	13	30	3
Primary Responsibilities	35	61	23
Immediate Actions	10	5	3
Preparatory Actions	19	53	51
Interior Shelter	101	102	35
Exterior Shelter	0	0	1
$\chi^2$		64.363**	
** = P < .001			

Overall, there is a significant difference in intended activities performed depending on lead time.

Figure 3: Categories of Activities by Lead Time



Question 3: Are there differences in the knowledge on how to respond between age groups?

Table 3: Chi Square analysis of responses between lead time scenarios

	2 Minutes		15 minutes		1 hour	
	YA	OA	YA	OA	YA	OA
Seek Information	15	3	20	13	18	13
Primary Responsibilities	27	8	37	24	15	11
Immediate Actions	3	7	1	4	1	2
Preparatory Action	13	6	33	20	24	27
Interior Shelter	61	40	52	50	19	16
Exterior Shelter	0	0	0	0	0	1
$\chi^2$	11.355*		5.336		2.862	

\* = p < .05

A significant differences between age groups was found only for the 2 minute lead time

- 2 minute:  $\chi^2(5, N=254) = 11.36, p=.02$
- 15 minute:  $\chi^2(5, N=58) = 5.336, p=.25$
- 1 hour:  $\chi^2(5, N=147) = 2.862, p=.72$

## Discussion

### Key Findings:

- Ideal lead times for students (42.9 min.) and older adults (24.4 min.) from the community are both considerably higher than the national average for actual tornado lead times (13 min.).
- When presented with a very short tornado warning, younger adults are more likely to seek out additional sources (i.e., other individuals, radio, internet) than older adults.
- Younger adults take action for ensuring the safety of others, while older adults tended to approach warnings more independently.
- There are no age differences in actions performed for 15 min. and 1 hour lead times, but younger adults are more likely to seek out additional sources than older adults.

### Future Research:

- Increase external validity by replicating this interview:
  - More demographically diverse
  - Additional tornado prone communities
  - Non-tornado prone communities
- Compare mental models of the public with those of subject matter experts in the same communities.
- Determine effect of specific tornado impact on the individuals of their household on lead time vs. those only in a tornado prone community.

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