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Exploring southeast US mobile and manufactured home residents' anchoring decisions

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ABSTRACT

Forensic engineering assessments of tornado damage have consistently shown that inadequate or absence of anchorage of mobile and manufactured homes (MMHs) has been the primary cause of structure failure, leading to high tornado fatality rates in the Southeast United States. Therefore, it is important to determine whether these residents have anchored their homes and their underlying motivations. This research quantitatively explored various factors influencing Southeast US MMH residents' current anchorage decisions and qualitatively explored other contextual factors for these decisions, including general mitigation knowledge and financial means. Results showed age, insurance, community shelter access, and self-efficacy perceptions reliably distinguished those who have already anchored their homes from those who have not and have no intentions to do so. On the other hand, among those who have not already anchored their homes, only tornado risk perceptions marginally distinguished those with intentions to anchor from those without. Also, those not already anchored were least likely to believe in the five tested myths and were potentially willing to spend \$500–\$999 on general mitigation, though few had ever considered fortifying their MMH and cost was the most cited barrier to doing so. The majority of participants knew nothing about the wind resistance of their home and only half of the sample knew the mitigation term, "manufactured home tie-down." The knowledge gained here can help various public-facing communication entities design effective outreach materials to facilitate this population better protecting themselves from tornadoes by way of strengthening their vulnerable homes.

1. Introduction

Tornadoes have caused \$10B in property losses annually in recent years [1], although the potential is much higher. In the 2011 tornado outbreak, for example, tornado-induced property loss exceeded \$12B and 321 people were killed [2,3]. The tornado fatality rate is highest in the Southeast (SE) US because—at least in part—a greater prevalence of tornadoes at night is juxtaposed with a higher percentage of people living in mobile and manufactured homes (MMHs) [4–7]. In fact, tornado fatalities are 15–20 times greater in a MMH than in a permanent home [7], with statistics for the past eight years showing 20–68% of fatalities in MMHs [8]. For instance,

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during a SEUS tornado outbreak on January 20–22, 2017, 21 people were killed, the majority of whom were in MMHs [9]. Forensic engineering assessments of tornado damage have consistently shown that inadequate or absence of MMH anchoring was the primary cause of structural failure. As one example, Roueche et al. [10] and Strader et al. [11] examined structural damage after the 3 March 2019 tornado outbreak preliminarily found lack of proper anchorage in MMHs of all ages to be a key contributor to the high fatality rates in the EF-4 Beauregard/Smith Station tornado. Frequent significant material degradation in MMHs due to corrosion and other natural processes was also an important contributor. When in-ground anchors (Fig. 1) corrode, or MMHs lack in-ground anchoring (e.g., have a pan system in place or no anchoring at all; Fig. 2), specific strategies are needed to facilitate mitigation and resilience because these structures become even less likely to be able to withstand strong winds. Therefore, it is critical to understand how the MMH owners make decisions about improving the strength of their homes.

1.1. Background information and relevant literature

1.1.1. Social vulnerability in the southeast U.S

The specific instances of high fatality rates occurring in mobile and manufactured homes in 2017 and 2019 cited above are illustrative of the broader context of social vulnerabilities that lead to greater impacts from tornadoes in the SEUS. An analysis of 50 years of tornado records shows this juxtaposition of tornadoes with vulnerabilities in a broad sense, finding a climatological peak of tornado *hazards* (meaning tornadoes that cause injuries, fatalities, and/or economic losses) to the southeast of the climatological peak of tornado *reports* [12]. Vulnerability has two components: exposure to a risk and sensitivity to that risk [13] and these are maximized in the SEUS, where a relatively high risk of tornadoes occur where there are also higher percentages of developed land, and greater percentages of MMHs in the housing stock [14] (see also Table 1). Many MMHs are single-sited and not collocated with tornado shelters rather than being concentrated in mobile home parks [13,14]. As recognized by the Social Vulnerability Index [15], social factors can have an additive effect on overall vulnerability. Mobile and manufactured home residents are a diverse population; however, they are represented in greater proportions across a range of social vulnerabilities. For example, there are higher percentages of people with disabilities and substance abuse issues [15]; elderly citizens who often have decreased mobility, higher rates of health issues, and poorer hearing [15–18]; migrant populations with language limitations [19,20]; and people living below the poverty level [21]. Further, researchers have found a slight majority of this population believes their home is a safe shelter location for a tornado [22] and fewer than 30% evacuate ahead of a tornado, despite the safety guidance given by the NWS and FEMA [23–25].

1.1.2. About MMHs

Mobile and manufactured homes are the only home type subject to a national building code [26]. Congress passed the first of three building code standards in 1974 (42 U S C. 5401–5426), which led the US Department of Housing and Urban Development (HUD) to regulate the construction of all MMHs built in the US through the enforcement of Manufactured Home Construction and Safety Standards (i.e., HUD codes). From 1976 onward, new MMHs were called manufactured homes. Then, in 1994, wind load requirements were added to the HUD code for high wind risk areas. Referred to as the "Wind Standard," this update was motivated by the devastation caused during Hurricanes Hugo (1989) and Andrew (1992) where even well-anchored homes had completely failed above the chassis and floor; this standard also regulated levels of formaldehyde outgassing. Finally, in 2006, a code update strengthened the fastening of structural systems, which was driven by engineering analyses of the Hurricane Charley aftermath [27]. Note that the construction of the home itself is a separate issue from how it is anchored (or not) to the ground. State, local, and regional building codes (e.g., International Building Code, ASCE 7, ACI 318, etc.) are not mandatory and structural approval by a local inspector is generally not required. The state of Florida instated tie-down requirements in 1999 [28] but most states have minimal, if any, requirements outside of hurricane zones (e.g., HUD Zones II and III) [29]. Thus, it is perhaps not a surprise that many of these homes are inadequately anchored, which is consistently shown in post-tornado forensic engineering assessments as the primary cause of structure failure [2, 10].

The above code changes have led to dramatic differences in damage to MMHs in hurricane zones. Grosskopf [30] found MMHs constructed with the 1994 post-Hurricane Andrew code changes remained intact during the 2004 Hurricane Season as compared to nearby homes constructed before 1994, which suffered severe to catastrophic damage. Similarly, Simmons and Sutter [28] found that after two February 2007 tornadoes in Lake County, Florida, MMHs constructed after 1995 performed significantly better; those homes

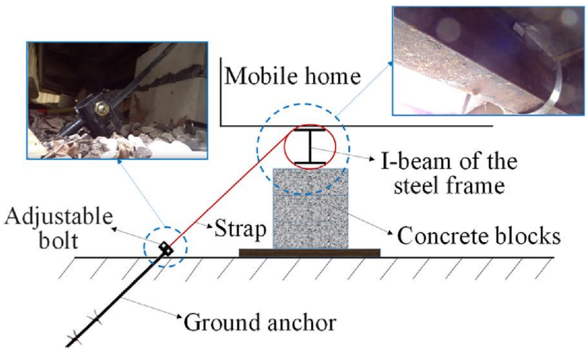

Fig. 1. Standard in-ground anchoring system for manufactured/mobile home.

Fig. 2. Example pan system on manufactured/mobile home that experienced catastrophic failure (Overturning).

Table 1
Sample breakdown by state and corresponding MMH housing stocks from the 2019 US census.

State	Participants		Proportion of Housing Stock
	n	%	%
Alabama	29	18.6	13.2
Arkansas	17	10.9	12.1
Georgia	28	17.9	9.0
Kentucky	27	17.3	11.8
Louisiana	18	11.5	13.1
Mississippi	13	8.3	15.1
Tennessee	24	15.4	9.2
United States			6.0

built to the new wind load requirements were 75% less likely to be destroyed as compared to those built before 1976. Simmons and Sutter argued that if all MMHs were constructed to the wind load and tie-down requirements, fatalities could have been reduced by 70%.

MMH damage can likely be reduced by as much as 50% by simply using HUD Zone III installation standards throughout wind-prone areas in the US [31]. However, MMH owners are likely unaware of this or high wind mitigation techniques in general. In Gast et al.'s [32] convenience sample of 153 visitors to the National Weather Center in Norman, Oklahoma—comprised of potentially weather salient participants—a mere 14% reported having heard of the critically important concept of a continuous load path. Although 66% in Gast et al.'s study were reportedly willing to spend $1000 or more on mitigation, Ripberger et al. [33] found tenuous support for mandatory mitigation, with only 27% "certain" to vote for a hypothetical mandatory code in a statewide referendum.

Anchoring itself has mainly been studied from physical and engineering perspectives (e.g., structural benefits, effective methods, reduced fatality rates). However, general knowledge of mitigation techniques, anchoring as a mitigation strategy, and factors influencing individuals' motivations to anchor their homes, especially among MMH residents have not been widely examined. Similar to other types of protective action decisions, whether homeowners are willing to install and/or maintain in-ground anchoring could depend on a variety of factors, including individual differences in decision making, whether they understand and personalize the risk posed by tornadoes, and their cognitive appraisals of anchoring such as being knowledgeable of the benefits relative to the costs (including financial and psychological costs) and understanding its effectiveness.

1.1.3. The roles of individual differences in protective decision-making

Individual differences are traits or characteristics that distinguish one person from the next [34] and have been shown to relate to individuals' decision-making across a variety of domains. Though the impact of individual differences on anchoring decisions specifically has not been thoroughly examined, the roles of various individual differences in protective action motivation have been widely studied in other threat domains. These include in response to health threats as well as in other aspects of severe weather decision-making, such as understanding probabilistic forecasts.

Studies in the health threat domain have shown individual differences such as anxiety [35], need for cognition [36], and numeracy [37,38] impact different types of decision-making among both the public and healthcare providers. As it pertains to weather-related decision-making, numeracy has also been shown to be an important individual difference to consider, especially when talking about probabilistic forecast understanding and usage. Grounds and Joslyn [39], for example, found that higher numeracy led to better decision quality when participants made protective spending decisions based on uncertainty forecasts, especially when the forecast included the probability of freezing. Most germane to the present research, though, is the need for cognitive closure (NFC), defined as an individuals' need for an answer, any answer to a problem as compared to remaining in a state of confusion or ambiguity [40,41]. Typically, a person who is high in NFC has a lower tolerance for uncertainty and is more likely to make quick decisions so as to arrive at an answer and satisfy their state of ambiguity whereas a person who is low in NFC is more likely to consider a variety of information and take their time in making a decision.

Previous studies on health-protective decision-making have found mixed results for the role of need for closure on willingness to engage in protective actions. For example, Eiser and Cole [42] examined the relationship between individual differences in NFC and stages of behavioral change [43] in women's cervical cancer screening decisions. They hypothesized and found that women who were high in NFC were more likely to be screened or contemplate being screened for cervical cancer. On the other hand, Cole et al. [44] used a similar model to examine African American college students' H1N1 vaccination decisions and found the opposite; those who were high in NFC were less likely to be vaccinated or contemplate vaccination after controlling for other demographic factors and potential vaccination barriers. Cole and colleagues noted various differences in the circumstances between both the threat (cervical cancer vs. H1N1 influenza) and the recommended protective action (screening vs. vaccination), and argued that NFC may have complex effects with other individual traits that should be explored. The present research builds on these previous studies [42,44] and extends them into the severe weather protective decision-making domain. Further, the present research provides an initial exploration of the role of need for closure in a more long-term mitigation strategy as compared to previous research that focused on more immediate protective actions that can be taken in the face of a threat.

1.1.4. The roles of risk perceptions and other cognitive appraisals in protective decision-making

The roles of risk perceptions and other cognitive appraisals in protective decisions have also been vastly studied in a variety of behavioral domains. In the health domain, process models attempting to explain protective decision-making [35,44,45] include factors such as risk perceptions, cost-benefit analyses, one's perceptions of their ability to successfully perform protective actions (self-efficacy) and the effectiveness of the protective action if taken (response efficacy). The Protective Action Decision Model [46] is a process model proposed to explain protective decision-making in the face of environmental hazards and disasters specifically. This model argues that, generally, protective decisions are multistage and impacted by multiple social and environmental factors, but this process is not initiated until people first perceive threat and/or danger cues. Then, a series of pre-decision processes elicit relevant threat, protective action, and stakeholder perceptions that, along with situational facilitators and barriers, then influence protective decisions. Shivers-Williams [47] found that personal values, expectations, perceived barriers to action, and mortality salience influence individuals' protective choices during multiple hypothetical severe weather situations. Other social research [48,49] has also shown some factors (e.g., past experiences, personal susceptibility, barriers to action) differentially affect various demographic groups in severe weather response. All-in-all, these types of decisions are complicated and can vary by the hazard to which people are responding, but are important for life-saving efforts. These studies (and others conducted in a similar vein) often examine the motivations underlying protective response behaviors such as seeking shelter from a tornado or evacuating before an impending hurricane, but researchers have spent far less time on those that underlie mitigative behaviors (referred to as long-term hazard adjustments) [31] such as strengthening a MMH by anchoring it. Thus, there is a crucial need to more deeply examine the motivations that underlie anchoring decisions.

1.2. The present research

Anchoring is critically important for protecting vulnerable structures such as MMHs, but without understanding individuals' rationales for why they did or did not choose to anchor their homes as well as barriers they may experience that hinder their efforts, interventions and communications aimed at improving the likelihood MMH residents will anchor their homes may fall short or be ineffective. Because MMHs are vulnerable structures, it would be a reasonable alternative protective plan to seek shelter in a stronger structure such as a public or community shelter, but this strategy is not practical for nighttime tornadoes. Also, many places in the SEUS do not have community tornado shelters. Even in the places that do, the available shelters cannot accommodate the entire population. For example, many counties in Alabama have community tornado shelters, but those shelters can only house 2–17% of residents [50], which is only a small portion of the population when the housing stock itself is 13% MMHs [51]. Further [52], found that 85% of survivors directly affected by the 3 March 2019 Lee County, Alabama tornado did not take shelter until after directly hearing or seeing the tornado, which would be too late to travel to a shelter. Thus, it is important to focus efforts on understanding MMH residents' anchoring decisions so that communications and educational campaigns aimed at better informing these populations have a higher likelihood of success.

The overarching goal of this research was to gain a better understanding of MMH residents' knowledge of general mitigation techniques and their current anchorage status as well as shed light on the factors that have influenced their anchoring decisions. A variety of analytic techniques were used to achieve this goal. First, we examined summary statistics about our sample to gain a better understanding of the demographic differences among participants. Then, based on previous research, we hypothesized that MMH residents' decisions regarding MMH anchoring would be influenced by their (1) individual differences in need for closure, (2) tornado risk perceptions, (3) a cost-benefit analysis of anchoring, and, (4) efficacy perceptions of MMH anchoring. Lastly, we explored their mitigation knowledge and other relevant factors that might provide more in-depth information for the rationales/motivations underlying these relations or more personal context in which these decisions are made.

The knowledge gained from this research will help practitioners and communicators design effective outreach materials for MMH residents. Further, these findings will also reveal those MMH residents who are least likely or unable to anchor their homes, thus potentially identifying those most likely to benefit from community tornado shelters. This also could have implications for determining adequate lead time messaging goals. Taken together, these novel research efforts are aimed at eventually empowering MMH residents to make an informed decision regarding the anchoring systems of their MMHs.

2. Method and materials

2.1. Participants and procedure

Data discussed in this paper were collected as part of a larger grant project conducted across multiple institutions that examined MMH residents' anchoring perceptions and practices from both engineering and social science perspectives. The study reported here was approved by the University of Oklahoma's institutional review board. Qualtrics (https://www.qualtrics.com) sampled and managed online data for 156 participants during January and February 2021. Participants completed an electronic consent form and were administered questionnaires. The median survey completion time was approximately 22 min. Qualtrics screened for "fast responders"—participants who completed the entire survey in one-half the median time or less—and terminated them for not responding thoughtfully. After survey completion, participants read an electronic debriefing form and were paid for their participation commensurate with the Qualtrics pay schedule.

For the purposes of this paper, we focused on a subset of the overall project's variables (the variables described below), which focus specifically on MMH residents' anchorage decisions and factors that influence and contextualize these decisions. We examined adults who self-reported living in MMHs in the following Southeast US states as defined by the National Oceanic and Atmospheric Administration Verification of the Origins of Rotation in Tornadoes Experiment in the Southeast U.S. (VORTEX-SE) Research Program: Arkansas, Louisiana, Mississippi, Tennessee, Kentucky, Alabama, and Georgia. These states were chosen because they are heavily impacted by tornadoes and severe thunderstorms and they are among the states with the highest incidence rates of mobile homes in the overall housing stock (ranging from 9.0% to 15.1%) [51]. Table 1 shows a breakdown of the sample by state as well as the corresponding MMH housing stocks for each state.

2.2. Measures

2.2.1. Individual psychological difference measures

2.2.1.1. Need for closure. A short form of Kruglanski's NFC scale [53] was administered to measure individual differences in comfort with uncertainty. Sample items included, "Any solution to a problem is better than remaining in a state of uncertainty" and "Any solution to a problem is better than remaining in a state of uncertainty." Responses were indicated on 6-point Likert scales, with options ranging from *strongly disagree* to *strongly agree*. Higher scores indicated a greater need for cognitive closure (i.e., less comfort with uncertainty). The NFC scale contained two lie items, "I have never been late for work or for an appointment" and, "I have never hurt another person's feelings." In accordance with the scale authors' instructions, participants whose mean lie item scores exceeded the scale's midpoint were excluded from all analyses involving NFC. Mean NFC scores were computed for the 101 valid participants using the scale's remaining 14 items (Cronbach's $\alpha = 0.81$).

2.2.1.2. Risk perceptions. The questionnaire included three questions assessing individuals' self-reported risk perceptions for different locations being affected by a tornado. Specifically, participants were asked to indicate "how much risk … the following places face in terms of being directly hit by a tornado" for their town/city, their home, and their neighbor's home. Responses were indicated on a sliding scale ranging from *0 (No risk at all)* to *100 (Guaranteed to be hit)* with three midpoints labeled at 25, 50, and 75. Risk perceptions were calculated by averaging responses to these three questions.[2] Higher scores indicated greater risk perceptions (Cronbach's $\alpha = 0.95$).

2.2.2. Cognitive appraisals

2.2.2.1. Cost-benefits analysis. Following [44], one item was adapted to assess participants' cost-benefit analysis of MMH anchoring. Specifically, participants responded to the item: "I feel the benefits of anchoring my mobile home outweigh the costs associated with anchoring it." Responses were indicated on the same 6-point Likert scale with options ranging from *strongly disagree* to *strongly agree*. Higher scores indicated a greater belief that the benefits of anchoring their MMH outweighed its costs.

2.2.2.2. Efficacy beliefs. The questionnaire included anchoring efficacy and self-efficacy measures adapted from Ruiter et al. [36]. Responses were indicated on 6-point Likert scales, with options ranging from *strongly disagree* to *strongly agree*. Anchoring efficacy was assessed by averaging responses to the following five items: "People who anchor their mobile homes are the least likely to be harmed," "Anchoring one's mobile home is an effective way to remain safe," "Anchoring a mobile home has strongly improved people's chances of surviving," "I am confident that anchoring a mobile home keeps people safe," and "I am confident that anchoring a mobile home is safer than not anchoring a mobile home" (Cronbach's $\alpha = 0.86$). Higher scores indicated a greater belief that anchoring is an effective strategy for keeping people safe. Self-efficacy was assessed by averaging responses to the following two items: "It would be easy for me to anchor my mobile home if I wanted to," and "I could successfully get my mobile home anchored" (Spearman-Brown $\rho = 0.78$).

2.2.3. Mitigation beliefs

2.2.3.1. Beliefs in protective "myths". Drawing upon previous research [32,54], all participants were asked to indicate which of several "myths" they agreed with in response to the statement, "I am generally safe from tornadoes because _______." Participants selected all of the "myths" with which they agreed from a predefined list. The statements provided were: (1) I live near a body of water (lake, river, etc.); (2) I live in a hilly/mountainous area; (3) I live in a big city/well-populated area; (4) I live in a valley; (5) tornadoes never hit twice and we've already had one recently; and, (6) I don't agree with any of these statements. Responses were coded and code

[2] Principal Component Analysis showed these three items loaded highly together on one component. The Eigenvalue for this component was 2.73, with 90.85% of the variance accounted for by this component. Component scores for each item were all greater than or equal to 0.93. Taken together, these findings indicated creating a composite variable for risk perceptions was appropriate.

frequencies per document were computed.

2.2.3.2. Knowledge of general mitigation terms. Adapted from previous research [32], all participants were asked to respond to the statement, "Please select all of the following terms/phrases that you have heard of in regards to tornado/wind damage prevention" by selecting multiple statements from a predefined list. Sample items included, "Anchor/J bolts," "Wind-rated or wind-braced garage door," and "Vertical and/or angled tie-downs for mobile/manufactured homes." Responses were coded and code frequencies per document were computed.

2.2.3.3. Willingness to spend money. Participants responded to several multiple-choice questions assessing the amounts of money they would be willing to spend to repair their homes. Specifically, participants were asked, "Generally speaking, how much would you be willing to spend to reduce damage to your home caused by tornadoes" ($0-$199/$200-$499/$500-$999/$1000-$1999/$2000-$4999/$5000 or more); "Generally speaking, how much money do you tend to set aside yearly for home repairs (if any)" ($0 (I don't plan for home repairs at all)/Less than $500/$500-$1000/$1000-$1999/$2000 or more); and, "If you learned about a new preventative measure that you could take to fortify or strengthen your home **today**, how much could you comfortably spend **right now** to implement it if you were interested" ($0-$199/$200-$499/$500-$999/$1000-$1999/$2000-$4999/$5000-$9999/$10,000 or more). Responses were coded and code frequencies per document were computed.

2.2.3.4. Preventative measures taken and motivation to consider fortifying MMHs. As in Gast et al. [32], all participants were asked to respond to the multiple-choice question, "Have you already taken any preventative measures to reduce the damage your house sustains from a tornado" (yes/no). Those who selected "Yes" were provided with an open-ended box to describe the preventative measures they had already taken. This open-answer question was coded inductively, criterion-referencing [55] against structural elements known to increase resistance from strong winds (anchorage is one of a few factors [26]). This strategy enhances our ability to distinguish subsets of respondents and can assist those working to enhance resilience to windstorms in the US [56]. Responses were coded first into one of three categories: a response describing actions, a statement that nothing could be done, or a response indicating uncertainty (e.g., "I'm not sure"). Responses coded under actions were then coded into one of two categories, either structural preventative measures or non-structural measures.

Then, participants received a follow-up question asking, "What would motivate you to consider fortifying or strengthening the structure you live in?" Participants were provided a list of pre-defined motivations and asked to select all of the statements with which they agreed. The statements provided were: (1) Reduced insurance costs; (2) Protect me and/or my family; (3) Protect the things I own (e.g., personal property, family heirlooms); (4) Avoid the hassle of having to rebuild my home; (5) I don't own the structure I live in; and, (6) Other, where participants were given an open-ended box to provide additional information. Option five was included to capture those participants who may be unable to take preventative actions because they do not own the home they live in and therefore cannot make those decisions. Responses were coded and code frequencies per document were computed. Responses to the "other" text box were coded into one of the fixed responses when possible or are otherwise reported.

2.2.3.5. Barriers to fortifying MMHs. Adapted from previous research [32,47], all participants were asked to respond to the question, "What factors, if any, would reduce your likelihood of taking preventative measures to fortify or strengthen [your home]" by selecting all of the statements from a predefined list with which they agreed. The statements provided were: (1) The cost(s) of implementing these preventative measures; (2) The hassle of getting it done; (3) The amount of time it takes to implement preventative measures; (4) I don't know what to do; and, (5) Other, where participants were given an open-ended box to provide additional information. Responses were coded and code frequencies per document were computed. Responses to the "other" text box were coded into one of the fixed responses when possible or are otherwise reported.

2.2.3.6. Benefits of fortifying MMHs. Adapted from previous research [32], all participants were asked to respond to the statement, "The benefits of taking preventative measures to fortify or strengthen my home are …" by selecting all of the statements from a predefined list with which they agreed. The statements provided were: (1) Me/my family would be less likely to be injured or die in a tornado; (2) I would be less likely to lose family heirlooms/photos; (3) I might be able to avoid the hassle of replacing my possessions; (4) I might be able to avoid the hassle of having to rebuild my home; (5) Lowered insurance costs; (6) Peace of mind; and, (7) Other, where participants were given an open-ended box to provide additional information. Responses were coded and code frequencies per document were computed. Responses to the "other" text box were coded into one of the fixed responses when possible or are otherwise reported.

2.2.3.7. Knowledge of preventing tornado damage. Based on previous research [32], a series of questions were used to assess participants' existing knowledge of how tornado damage can be prevented. First, participants were asked to answer the question, "Based on your current knowledge, what can be done to reduce tornado damage to a house" using an open-ended response box. This open-answer question was coded inductively as described in Section 2.2.3.4. Responses were coded into the following categories: structural, non-structural, nothing can be done, and unsure/do not know. Code frequencies per document were computed.

Then, participants were asked to answer the following multiple-choice question, "Up to what intensity on the EF-scale can a person significantly reduce tornado damage to a house" (EF-0/EF-1/EF-2/EF-3/EF-4/EF-5/None of the above. It is not possible to significantly reduce tornado damage to a house.). Participants were also asked to indicate their confidence in their answer to that question. Lastly, participants were asked to respond to a follow-up multiple-answer question, "Where did you learn about how to minimize tornado damage" by selecting as many sources as applicable from a predefined list. The list provided included sample sources such as, "I heard about it on TV," "I heard about it from family/friends," and "I learned about it from social media." There was also an "other" option with an open-ended box to provide additional information. Responses were coded and code frequencies per document were computed. Responses to the "other" text box were coded into one of the fixed responses when possible or are otherwise reported.

2.2.3.8. Knowledge of MMH wind resistance. Motivated by preliminary results from other research [57], participants were asked to indicate what they know about the wind resistance of their homes. Specifically, all participants were asked to answer the question, "What do you know about the wind resistance of your home? This could include what you were told when you purchased your home, anything a loan officer or home inspector told you, something you learned if or when you made any repairs or upgrades, or anything you generally know" using an open-ended response box. This open-answer question was coded inductively as described in Section 2.2.3.4. Responses were coded into the following categories: know nothing, unclassifiable (e.g., "it held up pretty well the last time a tornado came through"), provided a specific rating, stated belief of no wind resistance, stated a need for reinforcement, provided a factor that may increase resistance (e.g., it is anchored down), or stated a factor that may decrease resistance (e.g., I have a few soft floors and water-damaged walls). Code frequencies per document were computed.

2.2.3.9. Final miscellaneous question. A final open-ended question on the survey asked, "Now, is there anything else about your home that you would like to tell us that has not been captured in any of the above questions?" This open-answer question was coded inductively as described in Section 2.2.3.4. Responses to this question sometimes addressed items previously asked; therefore, codes from prior questions were used when appropriate. New information not captured in previous questions is reported below.

2.2.4. Anchorage status

Anchoring status was assessed by asking participants to indicate whether they had already anchored their MMH or intended to anchor it. Specifically, all participants were asked the following multiple-choice question: "Thinking about the mobile home you currently live in, please indicate its current anchorage status." Participants were given response options of "My mobile home is already

Table 2
Physical MMH and sheltering characteristics of participants by their stage of change.

Variable	Stage of Change							
	Total Sample[a] (n = 156)		Precontemplation (n = 35)		Contemplation (n = 22)		Action (n = 99)	
	n	%	N	%	n	%	n	%
MMH[a,b] Type								
Single-wide	105	67.3	24	68.6	14	63.6	67	67.7
Double-wide	50	32.1	10	28.6	8	36.4	32	32.3
Home Ownership								
Own	94	60.3	13	37.1	11	50.0	70	70.7
Rent	53	34.0	16	45.7	10	45.5	27	27.3
Other	9	5.8	6	17.1	1	4.5	2	2.0
Insurance								
Yes	70	44.9	7	20.0	7	31.8	56	56.6
No	71	45.5	21	60.0	14	63.6	36	36.4
Not Applicable	15	9.6	7	20.0	1	4.5	7	7.1
MMH[a,b] Manufacture Date								
Before 1976	19	12.2	4	11.4	3	13.6	12	12.1
During 1976–1994	39	25.0	12	34.3	5	22.7	22	22.2
During 1995–2006	46	29.5	5	14.3	6	27.3	35	35.4
During 2007–2020	27	17.3	4	11.4	5	22.7	18	18.2
Unsure	24	15.4	9	25.7	3	13.6	12	12.1
MMH[a,b] Foundation Type								
Crawl Space	111	71.2	27	77.1	14	63.6	70	70.7
Slab	37	23.7	5	14.3	7	31.8	25	25.3
Walk-out Basement	7	4.5	2	5.7	1	4.5	4	4.0
Home Shelter								
Yes	18	11.5	0	0.0	3	13.6	15	15.2
No	138	88.5	35	100.0	19	86.4	84	84.8
Community Shelter Access								
Yes	58	37.2	7	20.0	8	36.4	43	43.4
No	98	62.8	28	80.0	14	63.6	56	56.6
Community Shelter Commute[c]								
Less than 5 min	18	31.0	3	42.9	3	37.5	12	27.9
6–20 min	36	62.1	4	57.1	4	50.0	28	65.1
21–60 min	2	3.4	0	0.0	1	12.5	1	2.3
More than 60 min	2	3.4	0	0.0	0	0.0	2	4.7
Anchorage System[d]								
Anchor/Tie-down System	61	61.6	–		–		61	61.6
Pan System	10	10.1	–		–		10	10.1
Both Anchor/Tie-down and Pan System	11	11.1	–		–		11	11.1
Other	1	1.0	–		–		1	1.0
I'm not sure	16	16.2	–		–		16	16.2

[a] Within the total sample, one (1) participant did not respond to MMH type, MMH manufacture date, and MMH foundation type. This participant fell into the pre-contemplation stage-of-change group.
[b] MMH = Mobile or Manufactured Home.
[c] This question was only viewed by participants who indicated they had access to a community shelter. Therefore, for this question, n = 58 for the total sample. For the stage-of-change breakout, only seven (7) pre-contemplation participants, eight (8) contemplation, and forty-three (43) action participants received this question. These are the respective ns.
[d] This question was only viewed by participants who indicated their MMH was anchored (action participants). Therefore, for this question, n = 99.

anchored" or "My mobile home is NOT currently anchored." Participants who indicated their MMH is NOT currently anchored were asked a follow-up multiple-choice question about their intention to anchor their home with response options of "I DO intend to anchor my mobile home" or "I DO NOT intend to anchor my mobile home." Participants' responses to these questions were used to determine which of three stages of behavioral change each participant fell into [41]: pre-contemplation (MMH not currently anchored and no intentions to anchor); contemplation (MMH not currently anchored but intends to anchor); or action (MMH already anchored).

2.2.5. Demographics

Following previous research, several potentially relevant demographic variables were assessed. However, many of those assessed failed to provide an even distribution across categories and were therefore not retained for analyses. The demographic variables utilized in the analyses presented here included age, MMH type (Single-wide/Double-wide/Not sure), homeownership (Own/Rent/Other), homeowner's or renter's insurance (Yes/No/NA), MMH construction timeframe (Before 1976/During 1976–1994/During 1995–2006/During 2007–2020/Not sure), MMH foundation type (Crawl space/Slab/Walk-out basement), and public or community tornado shelter access (Yes/No) and commute (Less than 5 min/6–20 min/21–60 min/More than 60 min).

2.3. Statistical analysis plan

First, descriptive analyses were performed to examine sample differences across the demographic questions. These analyses were used to gain insight into differences among the people in the sample but also among the different types of MMHs they live in and the different anchoring systems they reported. Then, using SPSS 25 NOMREG, we performed a sequential multinomial logistic regression to examine differences in pre-contemplation, contemplation, and action participants' anchoring decisions. After controlling for demographic covariates (Model 1), we assessed unique contributions of individual differences in NFC and tornado risk perceptions (Model 2) and the set of cognitive appraisals (Model 3) to stage of change. Preliminary analyses to screen for multicollinearity, normality, outliers, adequacy of expected frequencies, and linearity of the logit were performed. All assumptions and minimum sample size requirements of NOMREG were satisfied. One outlier was identified through Mahalanobis distance ($\chi^2 = 27.88$, $p < .001$) but was not removed because it did not significantly change the observed pattern of results. Finally, we explored our sample's general mitigation knowledge and beliefs for additional context surrounding their anchoring decisions.

3. Results

3.1. About the sample

In terms of sociodemographic characteristics, the sample was predominantly female (55.8%), Caucasian (84.6%), and non-Hispanic (99.4%). The mean age was 44.38 years but ranged from 18 to 84 years of age. The majority of the sample had at least a high school diploma or equivalent (91%). Almost half of the sample (48.8%) reported their family income was less than $25,000. The majority of the sample reported having no children under the age of 18 or elderly dependents in their homes (67.3% and 73.7%, respectively).

In terms of physical MMH and sheltering characteristics (see Table 2), the majority of the sample (67.3%) indicated they were homeowners (60.3%) and lived in single-wide MMHs. The sample was evenly split between having homeowner's or renter's insurance

Table 3
Means and standard errors of the covariates, tornado risk perceptions, need for closure (NFC), and cognitive appraisals of anchoring for the total sample and separated by stage of change.

Variable	Stage of Change			
	Precontemplation (n = 29); *M* (*SE*)	Contemplation (n = 17); *M* (*SE*)	Action (n = 55); *M* (*SE*)	Total (n = 101); *M* (*SE*)
Means				
Age	39.83 (2.53)	41.13 (3.03)	49.65 (2.20)	45.67 (1.57)
Insurance (% insured)	26.09%	31.25%	59.62%	46.15%
Community shelter access (% access)	17.39%	37.50%	48.08%	38.46%
TOR Risk	35.10 (4.15)	52.25 (7.72)	45.40 (3.33)	43.58 (2.57)
NFC	3.49 (0.13)	3.61 (0.20)	3.68 (0.09)	3.61 (0.07)
Perceived severity	4.69 (0.55)	6.07 (0.59)	5.08 (0.39)	5.14 (0.28)
Self-efficacy	3.00 (0.25)	4.06 (0.33)	4.17 (0.17)	3.81 (0.14)
Anchoring efficacy	3.61 (0.18)	4.48 (0.22)	4.07 (0.15)	4.01 (0.11)
Cost-benefit analysis	0.62 (0.06)	0.76 (0.11)	0.85 (0.06)	0.77 (0.04)
Estimated marginal means[a]				
TOR Risk	38.86 (5.51)	52.41 (6.31)	47.44 (3.67)	46.24 (2.99)
NFC	3.45 (0.16)	3.56 (0.18)	3.77 (0.10)	3.59 (0.09)
Perceived severity	4.82 (0.60)	6.11 (0.69)	5.30 (0.40)	5.41 (0.33)
Self-efficacy	2.93 (0.30)	4.07 (0.34)	4.24 (0.20)	3.74 (0.16)
Anchoring efficacy	3.67 (0.23)	4.51 (0.27)	4.08 (0.16)	4.085 (0.13)
Cost-benefit analysis	0.66 (0.09)	0.79 (0.11)	0.84 (0.06)	0.76 (0.05)

Note. TOR Risk = tornado risk perceptions; NFC = Need for Closure scale.
[a] Estimated marginal means are adjusted with covariates evaluated at the following values: age = 45.72, home insurance (% insured) = 47%, and community shelter access (% access) = 39%.

(44.9%) or not (45.5%). About half of the participants (46.8%) reported living in homes constructed after 1994 when post-Hurricane Andrew wind standards were implemented by HUD [26] while 37.2% reported living in pre-1994 homes. Most respondents (72.4%) reported living in manufactured homes, meaning built after 1976. This is a critical distinction in housing infrastructure that may have implications decision-making. As appropriate, this term will be used to discuss differences in the patterns of findings between the total sample and the subset of manufactured home residents. Most participants (71.2%) indicated their home was installed with a crawl space foundation. Few respondents (11.5%) reported having a tornado shelter on their home premises, and only about one-third of the sample (37.2%) reported having access to a public or community shelter. Of those with access to a community shelter, the majority (62.1%) reported the drive took 6–20 min; only 18 people were within 5 min of a shelter.

In terms of anchorage status (see Table 2), nearly two-thirds of the sample (63.5%) reported that their home was anchored; these participants fell into the “action” stage of change. Among these participants who do *not* have anchored homes, 38.6% ($n = 22$) indicated they intend to anchor their homes—which placed them into the “contemplation” stage of change—while the remaining 61.4% ($n = 35$) indicated they have no intentions to anchor—which placed them into the “pre-contemplation” stage of change. Of the participants who have anchored homes, the majority (61.6%) reported having a tie-down anchoring system; few reported having a pan system (10.1%) or having both tie-downs and a pan system (11.1%).

3.2. Examining anchoring decisions

A sequential multinomial logistic regression was performed to examine differences in anchoring decisions across the different stage-of-change groups (excluding lie item participants; see Section 2.2.1.1. for description). Means and standard errors of NFC, cognitive appraisals, and model covariates were computed for the total sample and separated by stage of change (see Table 3). Table 4 summarizes the regression results. As previously mentioned, this analysis was performed using the total sample as well as the subset of manufactured home residents. The overall pattern of results remained the same. In an effort to avoid screening out many participants in an already small sample, the entire sample was retained for analysis and will be reported on here. However, key differences in statistical findings for participants who reside specifically in manufactured homes are discussed where applicable.

In the first model, we examined the effects of demographic covariates on anchoring decisions. One of the covariates examined had predictive power in determining a participant’s stage of change, namely age, χ^2 (2) = 6.40, $p = .041$, while the other two covariates were marginally significant predictors. Action participants were significantly more likely to be older than pre-contemplation participants ($OR = 1.05$; 95% CI [1.00, 1.09]). Action participants were also somewhat more likely to have home insurance (either renters or homeowner’s insurance; $OR = 3.32$; 95% CI [1.05, 10.46]) and access to a community or public shelter ($OR = 4.02$; 95% CI [1.12, 14.44]) as compared to pre-contemplation participants. In contrast, none of the covariates reliably (or even marginally) differentiated contemplation from pre-contemplation participants.

Next, we assessed whether individual differences in comfort with uncertainty and tornado risk perceptions improved stage-of-change predictions. Adding these individual difference measures significantly improved the overall model fit and prediction of participants’ stage of change, χ^2 (10) = 26.80, $p = .003$, Nagelkerke $R^2 = 0.30$. However, neither of these variables reliably differentiated action participants from pre-contemplation participants, and tornado risk perceptions only marginally distinguished contemplation participants from pre-contemplation participants, $OR = 1.03$; 95% CI [1.00, 1.06]. In other words, the odds of intending to anchor

Table 4
Sequential multinomial logistic regression models for anchoring decisions as categorized by stage of change.

Model	Action vs. Pre-Contemplation			Contemplation vs. Pre-Contemplation			Model Statistics	
	b	*SE*	*OR*	*b*	*SE*	*OR*	χ^2 (*df*)	R^2
Model 1							21.20(6)**	.24
Age	0.05*	0.02	1.05	0.01	0.03	1.01		
Insurance	1.20*	0.59	3.32	0.16	0.73	1.18		
Community Shelter	1.39*	0.65	4.02	1.05	0.76	2.85		
Model 2							26.80(10)**	.30
Age	0.04*	0.02	1.05	0.00	0.03	1.00		
Insurance	1.61*	0.67	5.01	0.68	0.81	1.98		
Community Shelter	1.31†	0.67	3.70	1.03	0.77	2.80		
TOR Risk	0.02	0.01	1.02	0.03†	0.02	1.03		
NFC	0.56	0.42	1.75	0.12	0.47	1.13		
Model 3							43.35(18)***	.45
Age	0.03	0.03	1.03	−0.02	0.03	0.98		
Insurance	1.57*	0.73	4.83	0.81	0.89	2.25		
Community Shelter	1.33†	0.71	3.79	0.73	0.83	2.08		
TOR Risk	0.01	0.02	1.01	0.02	0.02	1.02		
NFC	0.50	0.49	1.64	−0.07	0.54	0.93		
Perceived severity	0.01	0.12	1.01	0.10	0.15	1.11		
Self-efficacy	0.65*	0.26	1.91	0.43	0.30	1.54		
Anchoring efficacy	−0.15	0.38	0.86	0.59	0.45	1.80		
Cost-benefit analysis	0.98	0.92	2.66	−0.03	1.06	0.97		

Note. Precontemplation participants served as the reference group for all analyses. OR = odds ratio; R^2 = Nagelkerke R squared; TOR Risk = tornado risk perceptions; NFC = Need for Closure scale.
†$p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$.

one's MMH marginally increased as participants' perceptions of being prone to experience tornadoes increased.

Finally, we assessed whether various cognitive appraisals significantly improved model fit. These appraisals did significantly improve model fit, χ^2 (18) = 43.35, $p < .001$, Nagelkerke $R^2 = 0.45$. Self-efficacy, χ^2 (2) = 6.95, $p = .031$, was reliably associated with stage of change. After controlling for covariates and individual differences, the odds of anchoring one's MMH increased as individuals' perceptions of their ability to anchor their MMH increased (*OR* = 1.91; 95% CI [1.15, 3.17]). Notably, when examining only manufactured home residents, self-efficacy, χ^2 (2) = 11.93, $p = .003$, also reliably distinguished contemplation from pre-contemplation participants; the odds of contemplating anchoring one's home increased as individuals' perceptions of their ability to do so increased (*OR* = 2.22; 95% CI [1.08, 4.57]).

3.3. Exploring anchoring decision context

Finally, we examined several additional survey responses in detail, seeking to understand beliefs about tornadoes, knowledge of construction terms, financial ability to cover repairs or upgrades, what participants might have already done to prevent damage, what might motivate them to take action, what might prevent them from doing so, how they might benefit from preventing tornado damage, what they believe can be done, and what they know about the wind resistance of their MMH. Results are shown for all survey participants. Some questions also separate and report on the 22 participants intending to anchor their homes and the 35 who are not anchored and do not intend to anchor. Similarly, some questions also separate and report on the manufactured home residents specifically.

3.3.1. Beliefs in protective "myths"

When asked about their beliefs in various "myths" about tornado protection, more than half of all participants (n = 91, 58.3%) indicated that they did *not* hold any of the five common, but incorrect, beliefs about tornadoes that we tested (Fig. 3). Similarly, nearly two-thirds of participants both contemplating anchoring their homes (n = 14, 64%) and not intending to anchor their homes (n = 23, 66%) also indicated not agreeing with any of the myths presented.

The most commonly selected myth statement for pre-contemplation participants was, "I live in a hilly/mountainous area" (n = 7, 20.0%). These participants were also likely to select living near a body of water (n = 5, 14.3%) as a myth with which they agreed. On the other hand, contemplation participants were more likely to believe that living in a big city made them less likely to be hit by a tornado and were equally likely to select big city/well-populated and hilly/mountainous (n = 3, 13.6% for both). Interestingly, none of the pre-contemplation participants selected "Tornadoes never hit twice and we've already had one."

Regarding the 14 participants who selected more than one "myth," four people selected both hilly/mountainous and valley, while four others selected those two as well as body of water. Two participants selected hilly/mountainous and big city/well-populated, while two other participants selected tornadoes never hit twice, hilly/mountainous area, and then either body of water or valley. One participant selected body of water and hilly/mountainous area and another participant selected all five myths. Finally, one participant selected both hilly/mountainous are and "I don't agree with any of these statements."

3.3.2. Knowledge of general mitigation terms

Knowledge of certain key construction terms and how tornado damage to homes may be reduced are crucial to identifying

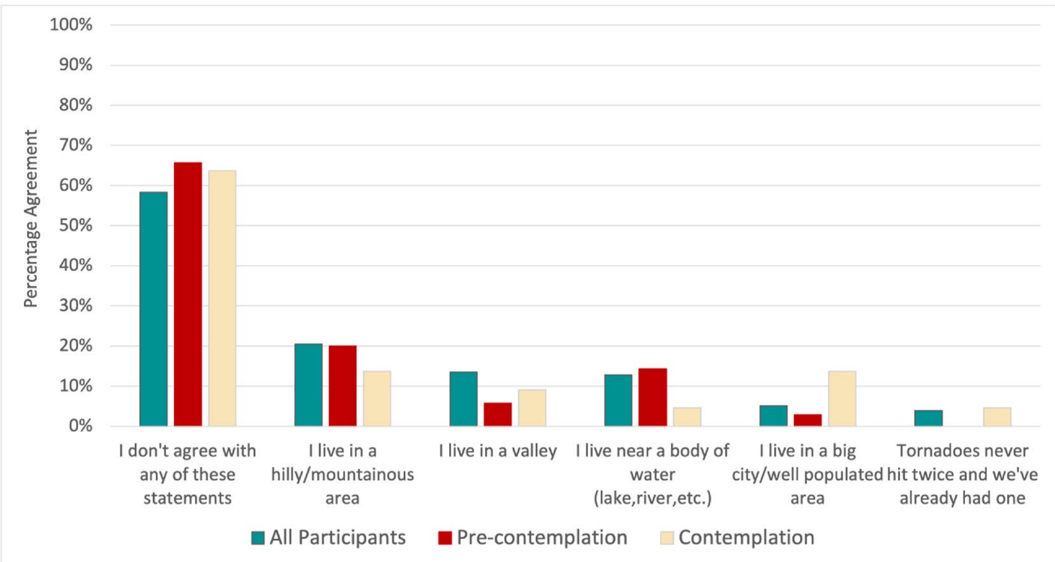

Fig. 3. Agreement with myth statements.
Note. The percentage of agreement with each myth statement is shown for the total sample, pre-contemplation participants, and contemplation participants. All participants had the option of selecting multiple myths with which they agreed.

opportunities and challenges for efforts aimed at increasing community resilience. When asked to indicate their familiarity with various general construction terms, the most commonly known term among all participants ($n = 78$, 50.0%) was manufactured home tie-downs. Additionally, many participants knew of hurricane straps or walk-out basements ($n = 66$, 42.3%; and $n = 64$, 41.0%, respectively). However, only a few participants knew of the term "continuous load path" ($n = 26$, 16.7%), a concept that means any wind loading on the structure is resisted throughout the structure all the way to the ground. Fig. 4 shows the full distribution for all terms presented for the total sample; many of which are structural elements used in frame homes rather than mobile homes. However, our interest was in general knowledge of structural mitigation elements so a variety of terms were included. Fig. 5 shows the distribution of participants indicating familiarity with MMH-specific construction terms.

These patterns held for the subset of manufactured home residents, with only 52% of all manufactured home participants indicating they were familiar with tie-downs and one-third of pre-contemplation and contemplation participants indicating familiarity with this term. This is particularly important because, for these residents, anchoring *is* the primary concern for their homes.

3.3.3. Willingness to spend money

Participants were asked three questions assessing their willingness to spend money to repair or prevent damage to their homes (Figs. 6–8). First, generally speaking, about one-third of all participants ($n = 55$, 35.2%) indicated they would be willing to spend between \$500 and \$1999 to reduce damage to their homes caused by tornadoes whereas just over half ($n = 12$, 54.6%) of contemplation participants would (Fig. 6). Second, pre-contemplation participants were least likely to set aside money for repairs ($n = 21$, 60.0%; Fig. 7) whereas only one-third of contemplation participants had no yearly budget ($n = 8$, 36.4%). Third, pre-contemplation participants were either unwilling to spend money or spend very little (\$0–\$199; $n = 24$, 68.9%; Fig. 8) on preventative measures now. Amounts that contemplation participants were willing to spend were distributed mostly among amounts below \$1999. The five participants who indicated \$10,000 or more reported their home was already anchored.

Among the 24 homeowners who reported not having anchored homes (13 pre-contemplation participants, 11 contemplation participants), the most common amount they would be willing to spend on mitigation was \$500–\$999 ($n = 10$, 41.7%), though the majority had either little available to spend on preventative measures now (0–\$199; $n = 11$, 45.8%) or less than \$500 saved for yearly repairs ($n = 5$, 20.1%). Almost half ($n = 11$, 45.8%) said they would be willing to spend \$0–\$199 now, with an additional 9 (37.5%) willing to spend between \$200–\$999 (not shown).

3.3.4. Preventative measures taken and motivation to consider fortifying MMHs

Less than one-third ($n = 33$, 21.0%) of all participants reported having already taken preventive measures. Of those, most of the efforts reported were structural ($n = 17$, 85.0%; Fig. 9): anchoring ($n = 14$), strengthening the roof ($n = 2$), having a strong foundation ($n = 1$), or reinforcing windows ($n = 1$). An additional five participants reported making non-structural efforts including either removing trees ($n = 2$) or preventing flying debris ($n = 2$). Other responses, which were not coded, included having an emergency radio, weather radio, flashlight, or backup food and water. Two participants mentioned making both structural and non-structural efforts.

When asked about what would motivate people to consider fortifying their home and excluding those who answered they did not own their home, a strong majority ($n = 92$, 80.7% of all; $n = 16$, 80.0% of contemplation participants; $n = 16$, 88.9% of pre-contemplation participants) said they would be motivated to protect themselves or their families (Fig. 10). More than half said

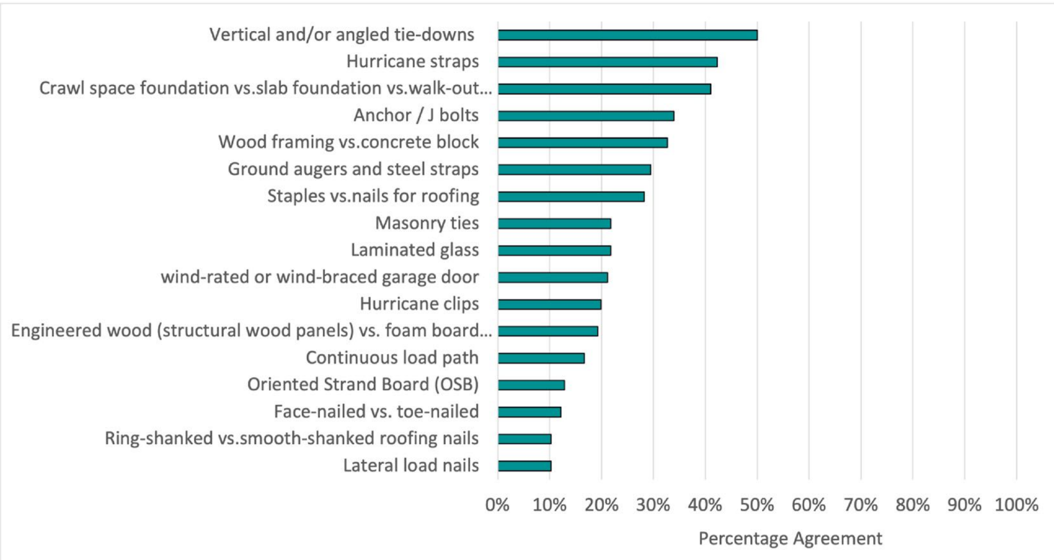

Fig. 4. Knowledge of general construction terms.
Note. The percentage of participants indicating knowledge of general construction terms is shown for the total sample.

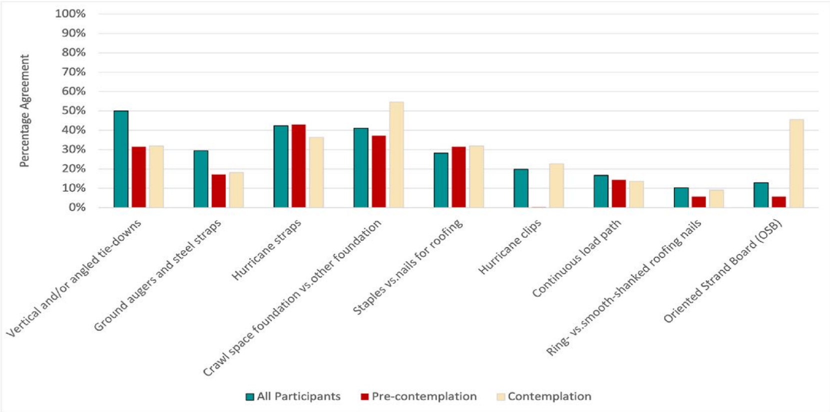

Fig. 5. Knowledge of MMH-Specific construction terms.
Note. The percentage of participants indicating knowledge of MMH-specific construction terms is shown for the total sample, pre-contemplation participants, and contemplation participants. All participants had the option of selecting multiple terms. MMH = Mobile and Manufactured Homes.

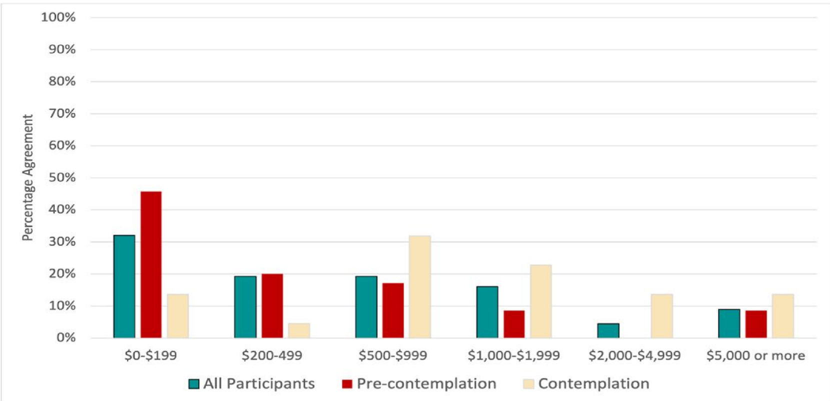

Fig. 6. Willingness to spend money on general mitigation.
Note. The percentage of participants falling into each category for how much money they would be willing to spend on general mitigation for their home is shown for the total sample, pre-contemplation participants, and contemplation participants.

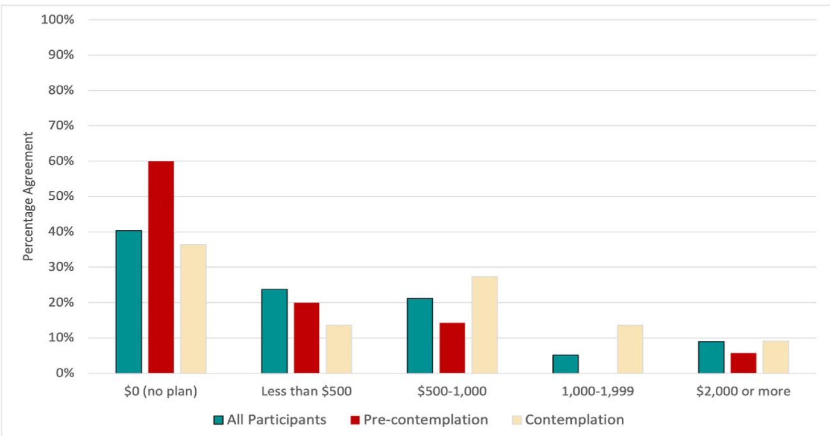

Fig. 7. Mean amount of money for yearly repairs.
Note. The percentage of participants falling into each category for how much money they typically set aside for yearly repairs on their home is shown for the total sample, pre-contemplation participants, and contemplation participants.

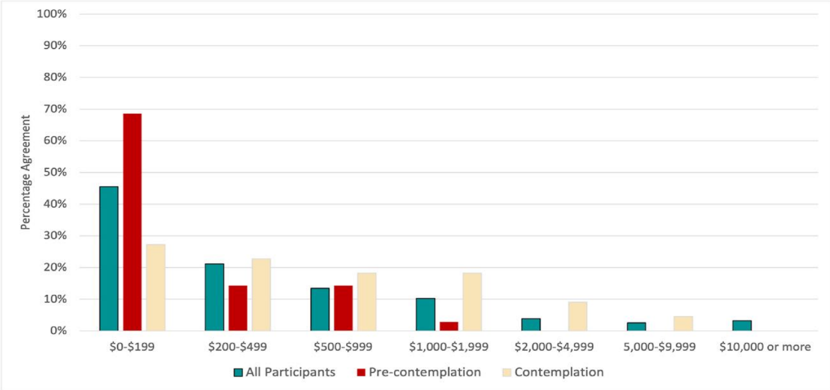

Fig. 8. Willingness to spend money on preventative measures now.
Note. The percentage of participants falling into each category for how much money they would be willing to spend now on a new preventative measure for their home is shown for the total sample, pre-contemplation participants, and contemplation participants.

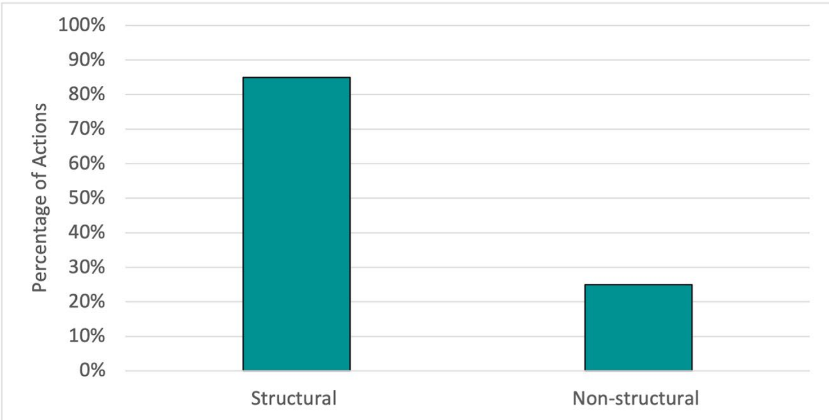

Fig. 9. Participants taking structural and non-structural preventative measures.
Note. The percentage of participants reporting taking structural and non-structural preventative measures for their homes is shown for the total sample.

they would want to protect the things they own. Contemplation participants were not as likely to be motivated to reduce insurance costs ($n = 5$, 27.8%) as they were to avoid the hassle of rebuilding ($n = 8$, 44.4%). Among the subset of manufactured home residents, a larger proportion (6%) would be motivated by reduced insurance costs and a lower proportion (7%) would be motivated to protect the things they own.

3.3.5. Barriers to fortifying MMHs

Participants were asked to indicate what would reduce their likelihood of taking preventative measures to fortify or strengthen their home (Fig. 11). Costs were cited by three-quarters of all participants and pre-contemplation participants ($n = 98$, 74.8% and $n = 18$, 75.5%, respectively) and two-thirds of contemplation participants ($n = 13$, 65%). Only about one-quarter of participants in all three groups cited the amount of time such actions would take as a barrier.

3.3.6. Benefits of Fortifying MMHs

Participants were also asked about the benefits of taking preventative measures (Fig. 12). The majority of the total sample, pre-contemplation participants, and contemplation participants ($n = 110$, 71.4%; $n = 27$, 81.8%; and $n = 16$, 72.7%, respectively) indicated that they and their families would be less likely to be injured or die and that such actions would provide peace of mind ($n = 94$, 61.0%; $n = 23$, 69.7%; $n = 11$, 50.0%, respectively). About one-third of the sample also selected lowered insurance costs ($n = 49$, 31.8%; $n = 12$, 36.4%; $n = 7$, 31.8%, respectively). Finally, one person entered the text, “Tornadoes are rare in my area.”

3.3.7. Knowledge of preventing tornado damage

Next, we explored whether participants believed that tornado damage could be reduced. About one-third of all, pre-contemplation, and contemplation participants ($n = 55$, 35.3%; $n = 10$, 28.6%; $n = 8$, 36.4%, respectively) indicated that nothing could be done to significantly reduce tornado damage to a house (Fig. 13). However, over half ($n = 65$, 57.7%; $n = 14$, 62.9%; $n = 13$, 59.1%, respectively) correctly indicated that damage could be significantly reduced for EF-0 to EF-3 tornadoes. A few participants indicated

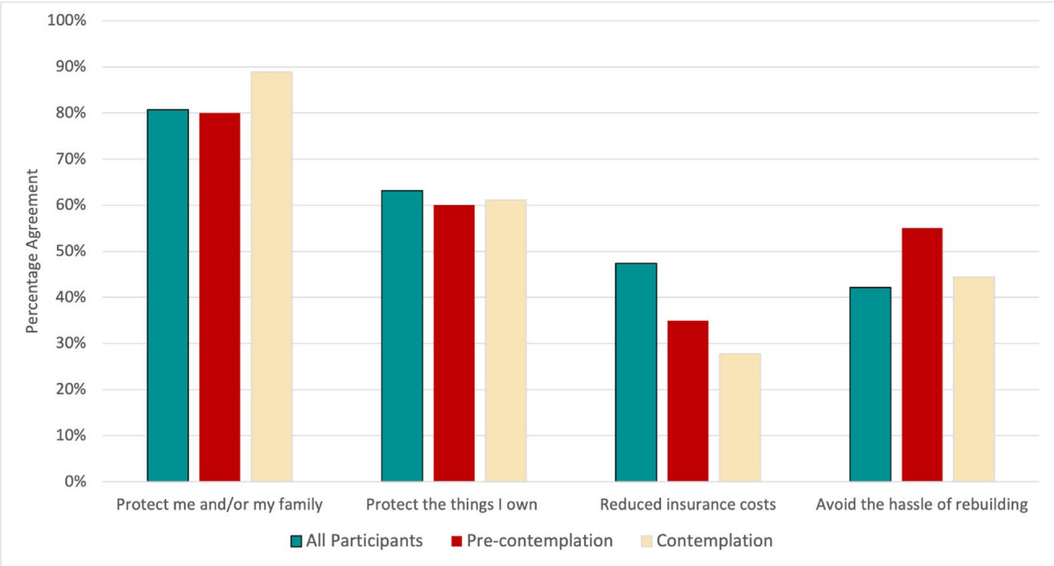

Fig. 10. Motivations to fortify MMHs.
Note. The percentage of participants indicating which reasons would motivate them to take mitigative actions to fortify their home is shown for the total sample, pre-contemplation participants, and contemplation participants. All participants had the option of selecting multiple reasons with which they agreed. Participants who selected "I don't own my home" and "Other" were omitted. MMH = Mobile and Manufactured Homes.

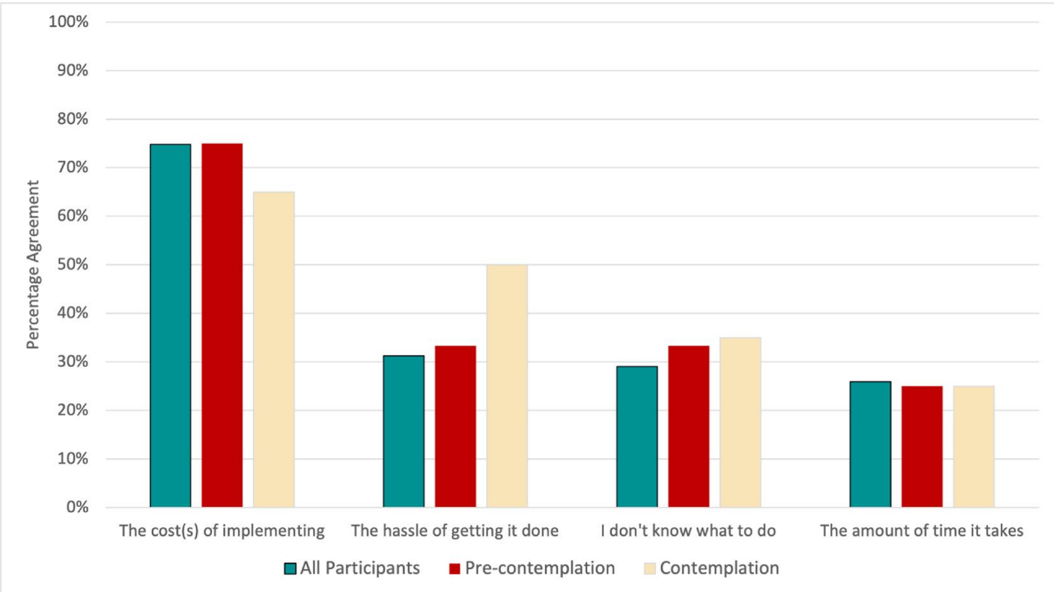

Fig. 11. Barriers impacting MMH residents taking mitigative actions.
Note. The percentage of participants indicating various barriers that have impacted their ability to take mitigative actions to fortify their homes is shown for the total sample. All participants had the option of selecting multiple reasons with which they agreed. MMH = Mobile and Manufactured Homes.

they thought tornado damage from EF-4 and EF-5 tornadoes could be significantly reduced. Participants were also asked how confident they were in their answers and their responses (Fig. 14), which revealed a wide range of confidence and uncertainty. Their knowledge most commonly came from hearing about it on TV (n = 40, 28.2%) or was an educated guess (n = 32, 22.5%). Less than 13–20% learned about this from watching the news, family/friends, the Internet, or at school. One person stated they had heard about this from their homeowner's insurance company.

Nearly all participants (n = 152) responded with their beliefs about what can be done to reduce tornado damage to a house. Answers were classified into "something" (n = 70, 47.6%), "nothing" (n = 47, 32.0%), and "I don't know" (n = 32, 21.8%). Of those who answered that something could be done, a strong majority (n = 58, 85.3%) described a structural change of some kind, whether

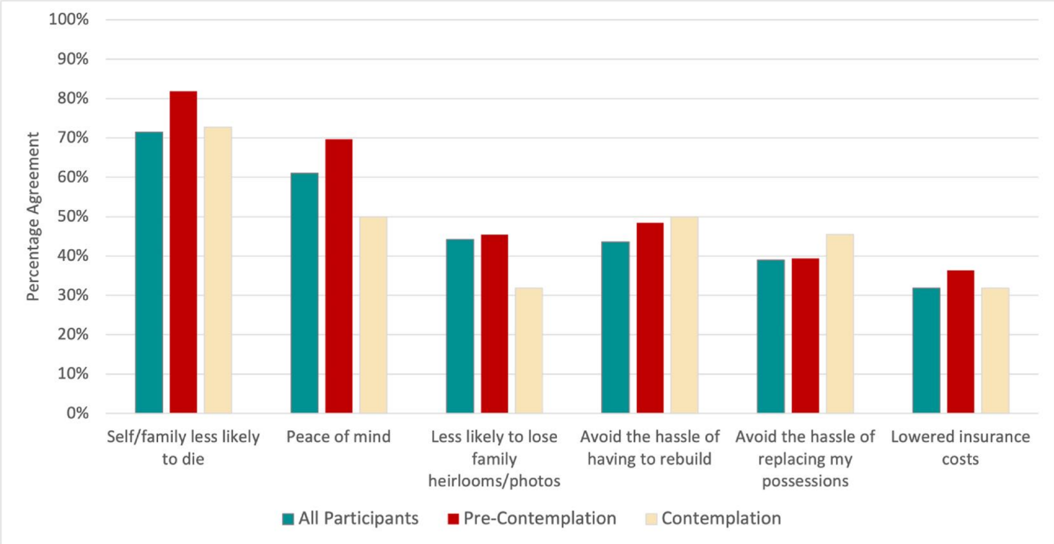

Fig. 12. Benefits of fortifying MMHs.
Note. The percentage of participants indicating various benefits to fortifying their homes is shown for the total sample. All participants had the option of selecting multiple benefits with which they agreed. Participants who selected "None" or "Other" were omitted. MMH = Mobile and Manufactured Homes.

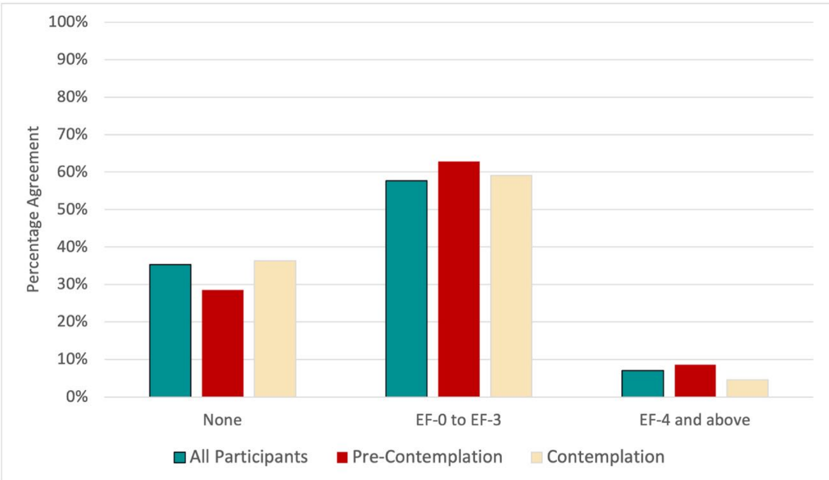

Fig. 13. Maximum intensity tornado damage that can Be reduced.
Note. The percentage of participants indicating the maximum EF-scale damage that can be reduced is shown for the total sample, pre-contemplation participants, and contemplation participants.

that was permanent (e.g., stronger materials, strong foundation, or roof connections) or temporary (e.g., boarding up windows). However, only 16% of the structural changes were specifically about anchoring. The remaining responses either did not involve the home or its connections (e.g., removing trees) or mentioned something that would not help mitigate serious damage (e.g., cleaning up loose lying debris or opening windows, the latter of which could actually increase damage to the home during a tornado).

3.3.8. Knowledge of MMH wind resistance

Participants were also asked about their knowledge of the wind resistance of their homes specifically. Out of 131 relevant responses, the majority ($n = 95$, 72.0%; Fig. 15) were coded as they did not know anything about the wind resistance of their home, while 13.6% ($n = 18$) expressed a belief that their home was not wind resistant, and 12.1% ($n = 16$) stated a factor and/or belief that their home may have increased resistance (e.g., home is anchored or strapped down, home is in a valley surrounded by mountains, the home went through Hurricane Katrina winds of 70+ mph for several hours and did not vibrate). A few participants ($n = 9$, 5.3%) stated a factor and/or belief that their home had decreased resistance (e.g. old and falling apart, shakes when windy, home is in an open field). Only 5.3% of participants provided a specific standard or wind speed rating, which varied from 100 to 200mph. These frequencies were computed after a few responses to the last survey question (see Section 2.2.3.9) were incorporated, adding one person to, "has a

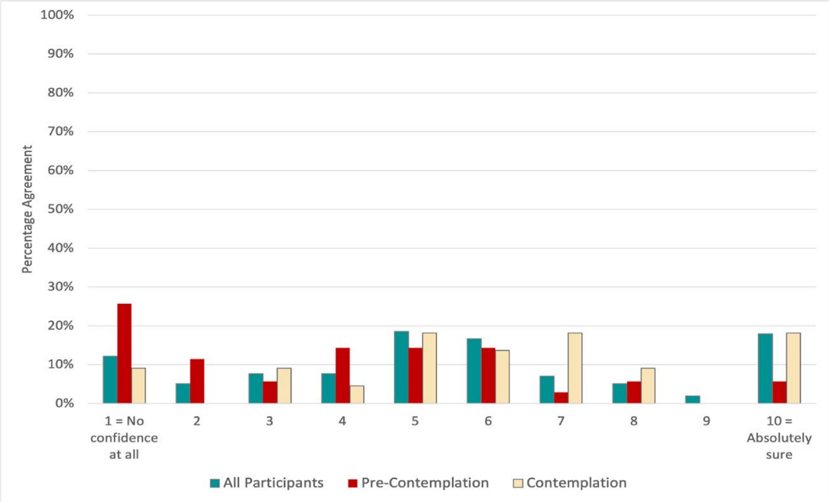

Fig. 14. Confidence in belief of maximum intensity tornado damage that can Be reduced.
Note. The percentage of participants indicating their confidence in their belief of the maximum EF-scale damage that can be reduced is shown for the total sample, pre-contemplation participants, and contemplation participants.

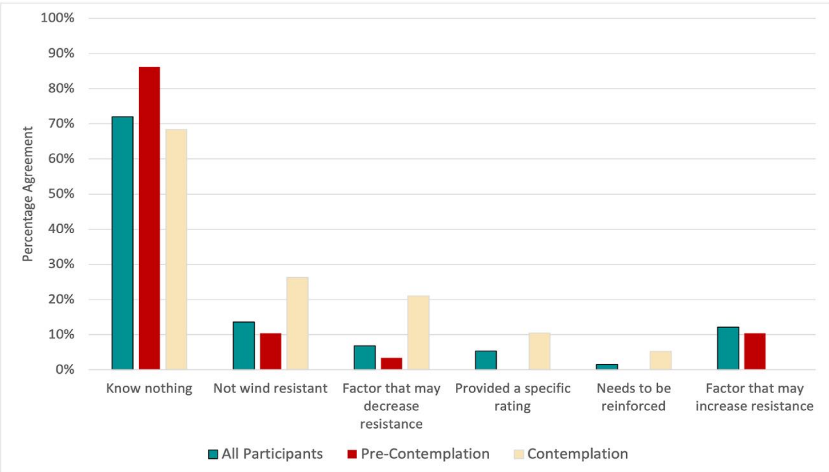

Fig. 15. Knowledge of MMH wind resistance.
Note. The percentage of participants falling into various categories of wind resistance knowledge is shown for the total sample. MMH = Mobile and Manufactured Homes.

factor that may have increased resistance" (e.g., my home has more anchors than required or hurricanes almost always hit us on the shorter end rather than the side) and four people to, "has a factor that may decrease resistance" (e.g., water damage to walls, home being higher on one end than the other, straps have rusted away).

Looking specifically at all participants with manufactured homes built after 1995, when the "wind standard" was enacted ($n = 73$), two-thirds reported knowing nothing about the wind resistance of their home ($n = 40$, 65.6%). Of the contemplation participants with homes built after 1995 ($n = 12$), two-thirds knew nothing about the wind resistance of their home ($n = 8$, 66.7%) and one third shared factors coded as belief that their home was not wind resistant or stated a factor that might decrease its wind resistance ($n = 4$, 33.3% for both).

3.3.9. Final miscellaneous question

The final survey question asked if there was anything participants would like to add about their home that was not previously asked. A few answers were relevant to the main survey questions and were coded using existing codes as described above to assure that code count-by-document caught these responses. For example, two participants described damage that meant a compromised structural integrity. These were also coded as "factor that may decrease resistance" for Section 3.3.8 and added to the reported frequencies in that section. Neither had stated this information before. Additionally, three participants stated they had learned something from the survey, which was not coded anywhere else but was interesting to know. Largely, however, responses to this question did not add any useful information.

In summary, our key findings are:

- Older age, having insurance (of some kind), access to a community shelter, and greater self-efficacy perceptions significantly distinguished those whose homes were already anchored from those whose homes were not anchored and had no intention of anchoring.
- Greater tornado risk perceptions marginally distinguished those whose homes were not anchored but intended to do it from those who were also not anchored but had no intentions to do it.
- Among manufactured home residents specifically, self-efficacy perceptions significantly distinguished those who intended to anchor their homes from those who had no intentions to anchor their homes.
- More participants were internally motivated (protect self/family, protect things I own, and avoid the hassle of rebuilding) than externally motivated (reduced insurance costs) to fortify their homes.
- Among manufactured home residents specifically, the motivations for fortify their home changed slightly: a higher proportion was motivated by reduced insurance costs and a lower proportion motivated by protecting the things they own.
- Few participants—including the subset of manufactured home residents—believed in common myths about tornadoes and only about one-third knew anchoring terms or about the wind resistance of their home, yet the majority of participants correctly believed that damage can be reduced for tornadoes up to EF-3 strength.

4. Discussion

Prior studies have examined motivations behind various protective actions, including seeking shelter from a tornado or evacuating before an impending hurricane, but not those that underlie mitigative behaviors such as strengthening a MMH by anchoring it. This work begins to fill that gap by examining the influence of multiple intrapersonal psychological factors on MMH residents' anchoring decisions. The results partially supported the hypothesis; individual differences in need for closure and cost-benefit analyses did not significantly impact MMH anchoring decisions among our sample, while efficacy perceptions were a significant predictor and tornado risk perceptions were a marginal predictor. We also found several demographic characteristics—age, home insurance, and community shelter access—were significantly related to MMH anchoring decisions. Further, many of these factors *only* reliably distinguished those who have already anchored their MMHs from those who have not and will not. In particular, those who have already anchored their MMH were more likely to be older, have insurance of some kind (homeowner's or renter's), and have access to community shelters as compared to those who have not already anchored their home and have no intentions to do so. Only one predictor—tornado risk perceptions—marginally distinguished those who have not already anchored their homes but intend to from those with no intentions to do so. This particular finding is somewhat consistent with previous research [58] in that risk perceptions were not a primary contributor to mitigation behavior; one caveat, though, is Scovell et al. [58] also studied what they termed "hazard intrusiveness" (i.e., talking and thinking about a hazard) and found intrusiveness to be a more important predictor for behavior than risk perceptions. Future research should work to examine the role of hazard intrusiveness in other mitigative behaviors. It is also worth noting, though, that when looking at only participants who reported living in manufactured homes (i.e., post-1976), self-efficacy perceptions *did* distinguish individuals who had not already anchored their home but intended to do so from those who had no intentions to do so. This finding suggests something unique among the manufactured home portion of our sample as compared to the entire sample; people living in manufactured homes may feel more able to prepare (or retrofit) their homes or perceive that this is even possible for their home type. Future research should examine this further.

We also explored participants' responses to several questions in more detail to glean contextual insight into their anchoring decisions. Over half of the participants in all three stage-of-change groups disagreed with the myth statements tested; like others [59,60], we tested only a few of all possible myths [61]. Of particular interest is our subgroups of participants with unanchored homes because belief in an erroneous myth may lead to being less interested in considering strengthening their home. Pre-contemplation participants were the most likely to disagree with the myth statements despite being marginally less likely to perceive a personal risk of being directly hit by a tornado compared to the other groups. They were most likely to believe in hills (20%) and water (14%) as having protective effects, the latter being similar to Walters et al. [62]. No myth was agreed to by more than 20% of participants, differing from some prior work [45]. Direct comparison with some prior research [62–64] is difficult due to methodological differences and incomplete reporting. Contemplation participants were the most likely (14%) to state that living in a higher population area meant they were less likely to be hit by a tornado. This myth has some reasonable basis: cities cover a relatively small surface area on a map and thus are less likely to be struck by pure odds alone. Will perceptions like this change in the future? Some researchers have been noting population spread as leading to increased amounts of damage because tornadoes are moving through areas that were undeveloped until recently [65]. Myths, then, may play a role in reluctance to take preventative measures, but may not be as significant of a contributor as other factors examined here.

Advances in structural engineering show that resistance of uplift force is possible and important to increasing resilience to windstorms of all kinds, which would be helpful for more MMH residents to know and understand in order to better fortify their homes. In the absence of laws or regulations, such as outside where HUD II and III standards apply, long-term protective action decisions cannot be made without knowledge of the mitigation technique [46]. Prior research [32] did not report results by home type but showed similar lack of knowledge as the present study, with the most known term by only half of participants. MMH residents could be reasonably expected to have some basic knowledge of important concepts related to wind resistance, yet less than 33% and 20%, respectively, knew the terms tie-downs or ground augers, and this pattern held for the subset of manufactured home residents. MMHs were originally rather fragile structures, motivating HUD to increase standards twice after examining MMH performance during major natural disasters [26]. For manufactured home residents, anchorage is the primary concern. Even a weak tornado can cause an unanchored or poorly anchored MMH to overturn or slide off its foundation [66]. Lack of knowledge about the most effective MMH anchorage is a challenge to increasing community resilience; consumers will not want or ask for something of which they are unaware.

Effectiveness of a mitigation strategy is important for its adoption potential [46]. The majority of participants in our study said that damage could be reduced from tornadoes up to EF-3 in strength. Generally speaking, both wood-frame and MMHs can be strengthened to resist damage from tornadoes up to that intensity [66]. When considering MMHs specifically, a MMH with typical anchoring will fail at about EF-2 strength winds, but there are documented instances of minimal damage to well-anchored MMHs with post-2006 manufacture dates during Hurricane Laura in an area of 130 mph winds [67]. Participants, then, were generally correct but varied widely on how confident they were in their answers regarding the level of damage that could be reduced.

After combining categories on how much participants were willing to spend on repairs or preventing damage in general, and avoiding the lowest category (which includes $0), just over one-third of pre-contemplation participants were able to spend between $200 and $999 ($n = 13$, 37.1%) and half of the contemplation participants were willing to spend $1000 or more ($n = 11$, 50.5%). Pre-contemplation participants were least likely to have a yearly repair budget, whereas about two-thirds of contemplation participants did. Looking at what they indicated they could spend now reveals a starker difference: 31% of precontemplation and 73% of contemplation participants could spend $200 or more. These three questions, taken together, may reveal both a general difference in affluence as well as an optimism for the future self as being more capable than the self of today.

More participants were internally motivated (protect self/family, protect things I own, and avoid the hassle of rebuilding) than externally motivated (reduced insurance costs) to fortify their homes. Taken with the results of their willingness to spend, these results suggest that while those who are not anchored have little to spend, they would *not* be strongly motivated by reduced costs of insurance. This is in contrast to Gast et al. [32], who found a much higher percentage of participants would be motivated to fortify their homes by reduced insurance costs (58% vs. our 35% contemplation and 28% pre-contemplation participants). Similar to this research, though, Gast et al. found cost to be a high barrier (76%). Protection of lives and property has been found as a motivator for fortification by others [68], but only when combined with other factors such as low cost and effort and the belief that the mitigation action added value to the home. Broader benefit-cost ratios may be of less importance to an individual homeowner than to a community but these efforts are broadly cost-effective for hurricanes [69]. It is unknown whether these are cost-effective for tornadoes and non-hurricane windstorms.

Finally, few participants knew much about the wind resistance of their home. A few participants provided a wind speed that did not equate to any HUD level and some of those values would imply that the home had been built—and installed—above HUD Zone III codes (which is unlikely). Contemplation participants were twice as likely to state that either their home was not wind-resistant or it had a factor that would decrease its resistance. Perhaps these beliefs are a motivating factor that would lead to them to consider anchoring their home. On the other hand, a minority of participants here and in Ash's study [70] believed their home to be better than average at surviving a tornado due to its position relative to the direction of strong winds (this study), proximity to tall trees on both sides (this study), size (double-wide) [70], or skirting material [70].

In summary, the novel contribution of this research was elucidating factors that influence a critical mitigative decision (i.e., anchoring MMHs) among a vulnerable population in the SEUS as well as finding relevant context within which to couch these decisions, which has interesting theoretical and practical implications. While there is extant literature on factors that influence protective decisions generally and even in specific regard to certain protective actions (e.g., evacuating, sheltering), there is scant research regarding anchoring decisions as a mitigative strategy against tornadoes and high-end wind events. Further, the findings here contradict some of the findings from other protective decision domains; namely, work examining the role of need for cognitive closure in protective health decisions [42,44]. Here, need for closure was not a significant distinguisher among those in different anchorage statuses; it was not significantly related to these decisions in any capacity. This may speak to a qualitative difference in the type of threat and protective decision examined here. Specifically, the health threats examined in previous studies were obvious and currently impactful threats (at the time of data collection) for a large portion of the population, which is what necessitated immediate action at the individual level. Also, the recommended protective actions against these threats (e.g., cervical cancer screening, H1N1 influenza vaccination) can be relatively easy and inexpensive to perform (e.g., health insurance can cover these costs). On the other hand, while the occurrence of a tornado is highly likely in particular parts of the US and during particular times of the calendar year, the impact to any particular MMH (and thus its occupants) is unlikely. This may then lead to the question of whether anchoring is *really* needed or if there are other protective actions one could take should the situation arise, and it can also create psychological distance between when the threat will occur and when the recommended protective action will be needed. Further, anchoring is a longer-term mitigative rather than shorter-term or reactionary strategy; ideally, one would want/need their home to be anchored *before* the threat occurs. These qualitative differences suggest there might be something uniquely complex about the role of need for closure in both weather-related protective decisions and longer-term mitigative strategy decisions.

This study is one of a growing number to study mitigation knowledge, attitudes, and behaviors using elements of the protective action decision model [46] and other prior research in order to understand potential barriers and opportunities to increasing the resilience of US housing stock. Most natural hazards research focuses on earthquakes and hurricanes; this is one of the only studies related to tornadoes.

4.1. Limitations and future research

The main limitation of our study was the sample size. Unfortunately, the sample size is not large or diverse enough to generalize to the entire population of MMH residents throughout the SEUS. While our results are useful and informative, a larger, more representative sample (i.e., representative across various relevant sociodemographic variables) would be of value to corroborate these findings. A larger sample may also firmly identify what those relevant variables could be in this specific context. Second (and potentially related to the first limitation), many of the variables had an unequal (or imbalanced) distribution across categories, including the primary dependent variable—anchorage status. In fact, almost two-thirds of this sample reported living in a home that was already anchored. While that is positive from a practical standpoint (we want as many people taking preventative measures for their vulnerable structures as possible), it does potentially impact some of the findings. In particular, we may be seeing null findings among variables simply because there were not enough people in each category to help us detect meaningful differences. Third (and also potentially related to the previous limitations), the way in which particular variables were operationalized may have led to null findings. For example, cost-benefit analyses have been shown to impact decision-making in a broad array of domains; however, this was an insignificant factor here. This could be a spurious finding due to the specific way we chose to define/measure this variable. Future research should explore other ways of tapping this (and other) cognitive appraisal(s).

Another limitation of this work is that the data is solely self-report. We did not consider attempting to objectively assess, through an online anonymous survey, whether respondents' homes were properly anchored and/or correct for their housing type. We provided pictures of the systems in an attempt to assist that self-reporting. Future research could look for methods to objectively corroborate individuals' perceptions of their homes—specifically their beliefs about the wind resistance—with the actual physical infrastructure. Further, presence of installation codes and enforcement of those codes was beyond the scope of this work. We were solely interested in what people thought they knew about the anchorage and wind resistance of their homes rather than the infrastructure itself. Related to this issue of installation is the marketing done by manufactured home builders and installers. This is a critical complementary concern of MMH anchoring but again, is beyond the scope of this particular work. Future research should examine how MMH companies market the installation of their homes and how consumers choose between installation options and whether they have a choice.

In addition to earlier suggestions, future research should seek to examine MMH residents' perceptions of, and access to, specific types of anchoring systems, especially in relation to the different failure mechanisms of their homes and whether they link the costs of maintaining these systems in their spending plans. Specifically, this research inquired about anchoring perceptions very generally, but how would these perceptions change if, for example, MMH residents could see how anchoring protects them and their homes during a tornado or high-end wind event? How does specific pricing (e.g., the cost of maintaining anchors or retroactively anchoring their MMH) or availability of installers impact their willingness and ability to do it? Do perceptions of anchoring change depending on the wind load strength that the anchors would be able to withstand? Future research should be conducted to examine this type of modeling for other types of weather-related protective decisions; a specific focus on other mitigative strategies/decisions would be especially beneficial to the field. More work is needed to understand the mitigative decision-making process, as preparedness is often under-studied in comparison to response and recovery. A related issue is the marketing done by manufactured home builders and installers. This is a critical complementary concern of MMH anchoring, but again, is beyond the scope of this particular work. Future research should examine how MMH companies market the installation of their homes and how consumers choose between installation options—and whether they have a choice. Severe weather risk messaging campaigns would benefit greatly from a deeper understanding of these decision processes and could, in turn, influence more proactive mitigative behaviors by incorporating key message elements as identified by research.

Finally, we recommend that researchers doing this type of work with MMH residents (or any vulnerable population) strive to meet an ethical obligation to prepare materials containing as much actionable and informative information as possible, especially in disaster-prone areas [71]. In our case, we provided information to a FEMA site on manufactured homes, a State Farm page linking to a safety checklist, and IBHS's research on manufactured home high-wind testing, but we did not provide specific information regarding the cost of anchoring or local/regional installers. Several respondents noted they had not thought about these issues much prior to taking our survey and thgaius appears to have been a missed opportunity for an educational intervention. We recognize the importance of this information in individuals' mitigative/protective decision-making processes as well as providing specific information about accessible installers for where participants are located.

5. Conclusion

Taken together, this work offers novel insight into MMH residents' current anchoring statuses and factors and context that may impact these mitigative decisions. This decision is complicated and certainly impacted by a variety of factors that vary interpersonally. These findings suggest that a group of MMH residents who have not already anchored their homes but intend to do so does exist and could be encouraged to anchor. More work is needed to reach residents of unanchored and poorly anchored MMHs particularly in the SEUS, where deadly nighttime tornadoes occur more often and alternate shelter is not always a viable option.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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