Structural Forces: Perception and Vulnerability Factors for Tornado Sheltering within Mobile and Manufactured Housing in Alabama and Mississippi

KEVIN D. ASH,[a] MICHAEL J. EGNOTO,[b] STEPHEN M. STRADER,[c] WALKER S. ASHLEY,[d] DAVID B. ROUECHE,[e] KIM E. KLOCKOW-MCCLAIN,[f] DAVID CAPLEN,[a] AND MAURYA DICKERSON[a]

[a] *Department of Geography, University of Florida, Gainesville, Florida*
[b] *Walter Reed Army Institute of Research, Silver Spring, Maryland*
[c] *Department of Geography and the Environment, Villanova University, Villanova, Pennsylvania*
[d] *Department of Geographic and Atmospheric Sciences, Northern Illinois University, De Kalb, Illinois*
[e] *Department of Civil Engineering, Auburn University, Auburn, Alabama*
[f] *Cooperative Institute for Mesoscale Meteorological Studies, National Severe Storms Laboratory, Norman, Oklahoma*

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ABSTRACT

Southeastern U.S. mobile and manufactured housing (MH) residents are the most tornado-vulnerable subset of the population because of both physical and socioeconomic factors. This study builds upon prior MH resident tornado vulnerability research by statistically and geographically analyzing responses from a survey administered to these residents in the Southeast. Specifically, 257 Alabama and Mississippi MH residents were administered a survey with questions pertaining to their perceived tornado risk and vulnerability, protective action and decision-making, and beliefs about the structural integrity of their homes. Results indicate that, despite the weather and emergency management enterprises consistently suggesting that MH residents evacuate their homes for sturdier shelter during tornado events, more than 50% of MH residents believe their homes are safe sheltering locations. The prevalence of larger MHs in northern Alabama partially influences willingness to shelter within one's MH, while higher levels of negative affectivity stemming from recent impactful tornadoes in northern Alabama influences people to evacuate their MHs for safety. Study findings also uncovered a perception and vulnerability paradox for these residents: Those who have the means to evacuate their MH often feel they have no need to do so, whereas those who recognize the potential peril of sheltering in their home and want to evacuate often lack the resources and/or self-efficacy to carry out more desirable sheltering plans. Overall, study results provide valuable information for National Weather Service forecasters, emergency managers, and media partners so that they may use it for public outreach and MH resident education.

1. Introduction

Tornadoes are a frequently recurring threat to lives and property in the United States. Previous research identified the southeastern United States as being of particular concern for tornado impacts, where elevated population densities and a variety of societal and environmental vulnerabilities intersect with a relatively high frequency of tornadoes, especially those occurring at night when effective communication and sheltering behaviors are more difficult to carry out (see Boruff et al. 2003; Ashley 2007; Ashley et al. 2008; Ashley and Strader 2016). The historically damaging and deadly tornado season of 2011 motivated new research initiatives to better integrate social science into the weather enterprise to reduce future tornado impacts via improved communication about tornado threats as well as tornado preparedness, response, and mitigation (Simmons and Sutter 2012; Lindell and Brooks 2013; Rasmussen 2015; National Academies of Sciences, Engineering, and Medicine 2018).

One key vulnerability factor that contributes to higher tornado fatality rates in the southeastern United States is the prevalence of mobile and manufactured homes

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Corresponding author: Kevin D. Ash, kash78@ufl.edu

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(MHs) in the region (Davies-Jones et al. 1973; Ashley 2007; Sutter and Simmons 2010; Lim et al. 2017; Strader and Ashley 2018). Mobile homes and manufactured homes are factory-built homes that are placed on a chassis and transported to an installation site. The distinction between them is that *mobile* homes, in industry parlance, were constructed prior to 1976 (Manufactured Housing Institute 2018), after which time national building code and siting regulations were established by Congress and subsequently required by the Department of Housing and Urban Development (HUD). *Manufactured* homes are those built in compliance with HUD codes since 1976, and these regulations still represent the current standard (Manufactured Housing Institute 2018). In this study, we use the acronym MH to refer to all mobile and manufactured homes [or all MH residents (MHR)], and we distinguish when necessary between mobile homes and homes manufactured to HUD code.

MHs are highly susceptible to damage or destruction from wind forces and impacts of flying debris (McPeak and Ertas 2012; Standohar-Alfano et al. 2018). According to the enhanced Fujita scale—the standard for tornado damage ratings in the United States that ranges from EF0 for minimal damage to EF5 for incredible damage—single-wide MHs can be completely destroyed by tornadoes with wind gusts corresponding to an EF1 rating, and double-wide MHs can be completely destroyed by wind gusts indicative of an EF2 rating (Edwards et al. 2013; National Weather Service 2019a). Furthermore, tornado fatalities in the United States are composed disproportionately—nearly 50%—of persons located in MHs (Simmons and Sutter 2011), and risk of fatality is 10 times as high for MHRs as for residents of site-built homes (Sutter and Simmons 2010).

Through comparative analysis of Alabama and Kansas, Strader and Ashley (2018) demonstrated that a significantly greater number of MHs, a greater geographic dispersion of MHs, and socioeconomic marginalization that sometimes coincides with MH residency are significant contributors linked to the unique tornado vulnerability in the southeastern United States. This problem is further compounded by a lack of designated tornado shelters located near MHRs in most southeastern states (Schmidlin et al. 2001, 2009; Strader et al. 2019). The result is that most MH residents in the region have difficulty planning a feasible sheltering plan that can be enacted within 15 minutes or less and, thus, resort to sheltering within their MHs during tornado warnings while hoping for safe outcomes (Chaney and Weaver 2010; Chaney et al. 2013; Ash 2015; Walters et al. 2019).

In this paper, we investigate perceptions about tornado protective action and intended sheltering behavior of mobile/manufactured home residents in Alabama and Mississippi, given the complex tornado vulnerability factors outlined above. Our goal is to improve understanding about how residents' past tornado experiences, their beliefs about their homes' ability to withstand tornadic wind speeds and debris, and their access to cognitive and instrumental resources all influence the type of actions residents are likely to enact when tornadoes threaten their communities. In so doing, we provide insight into how communication about tornado safety and response recommendations can be more effectively targeted for this subpopulation. We summarize the relevant academic literature and outline our research questions and hypotheses in the following section. We then describe our survey and analysis methods, present the results of our study, and conclude with discussion of the implications of our findings.

2. Background literature and research questions

The Protective Action Decision Model (PADM; Lindell and Perry 2012; Lindell et al. 2019) is a useful conceptual framework for our analysis of MHRs' intended tornado sheltering behaviors and the potential influences of access to resources, prior experiences, and beliefs about structural safety and wind resistance. The PADM represents individual or household decision-making and behavioral response as outcomes of a flow of warning and safety information filtered through environmental and social contexts, unconscious and conscious evaluation of relevant threats, stakeholders, and the efficacy of recommended protective actions [cf. model diagram in Lindell et al. (2019, p. 70)]. Cognitive and instrumental resources available to MHRs for protective action behaviors, their prior experiences, and their home wind resistance/safety beliefs are theorized within the personal characteristics portion of the model, which then influences threat and protective action perceptions and decision-making processes in the PADM. This current study does not attempt to empirically replicate every aspect of the PADM; we leave such an ambitious undertaking for future projects. We contend that protective action perceptions in particular have been understudied in the tornado context in the United States—especially for MH residents—and that beliefs about home safety and wind resistance may be equally important, if not more so, for protective behaviors than perceptions about tornadoes themselves.

a. *Access to resources and social vulnerability*

MH dwellers, and the MH industry at large, are often stigmatized by negative cultural, social, and economic stereotypes. Housing scholars have countered these stereotypes by recognizing that mobile and manufactured housing encompasses demographically, culturally, and geographically diverse groups of residents with wide-ranging values, concerns, and means (Beamish et al. 2001; Hart et al. 2002; Salamon and MacTavish 2017). Nevertheless, when compared to those living in site-built homes, MHR suffer disproportionate hardship in a number of contexts, including health and disability (Al-Rousan et al. 2015), energy use and efficiency (Wilson 2012), water utility service (Pierce and Jimenez 2015), and uncertain housing and land tenure (Sullivan 2018). It is not surprising, therefore, that MH prevalence (as a percentage of occupied housing stock) is often included as an indicator in geospatial analyses of social vulnerability to disasters (Emrich and Cutter 2011; Flanagan et al. 2011). However, vulnerability is not static but is dynamic; it may emerge and amplify due to both long- and short-term circumstances arising from societal structural forces, individual choices, and a host of additional factors (Terti et al. 2015; Wisner 2016; Gibb 2018). Too often research on social vulnerability focuses only on systematic disadvantages without considering the multilayered nature of vulnerability that includes the capacities and resources people may draw upon to lessen negative impacts (Lazrus et al. 2012; Wisner 2016).

In this research, we focus on capacities for coping with tornado threats that can aid in understanding sheltering decisions and behaviors. Access to multiple means of receiving warning information is critical because people tend to comply with official warnings and recommendations, especially when they are received via multiple information channels (Lindell and Perry 2012; Sherman-Morris 2013; Huang et al. 2016). Access to other types of resources may be used for very specific purposes in emergency situations, such as a functioning vehicle for evacuation (Ash 2015) or having financial security and job flexibility to miss work in order to ensure safety at home during inclement weather (Smith and McCarty 2009; Liu et al. 2019). Furthermore, Liu et al. (2019) found that many MHRs in the southeastern United States draw on their own personal psychological resources to cope with tornado threats, even in the absence of official information resources. We build from this work by investigating MHRs' access to and use of various information technologies for the receipt of warning messages and related safety information, emergency access to transportation and financial assets, and positive psychological capital. Drawing from the literature summarized in this section, we pose the following hypotheses related to information resources, emergency resources, and psychological resources:

- H1: Better access to information resources will be associated with 1) being less comfortable sheltering at home (H1a) and 2) a lower likelihood of sheltering within one's MH (H1b).
- H2: Better access to emergency resources (personal transportation and finances) will be associated with 1) being less comfortable sheltering at home (H2a) and 2) a lower likelihood of sheltering within one's MH (H2b).
- H3: Higher values of psychological capital will be associated with 1) being less comfortable sheltering at home (H3a) and 2) a lower likelihood of sheltering within one's MH (H3b).

b. *Beliefs about wind hazards and safety of mobile/manufactured housing*

In addition to social vulnerability arising from resource-related factors, there is also a knowledge gap in understanding how MH residents perceive the safety of their own homes and whether these beliefs play any substantial role in wind hazard preparedness, response, or mitigation actions. Previously, Ash (2015, 2017) studied MHRs' perspectives on tornado preparedness and protective action in South Carolina. He noted that, when asked about tornado risk and safety, MH residents often spoke in terms of their homes' physical ability to resist strong winds and debris as indicated by the structure's age, size, and building materials (Ash 2015, 2017). Ash (2015) also analyzed over 200 questionnaire responses and found that MHRs who were less concerned about tornadoes were significantly more likely to live in double-wide MHs (as compared with single-wide MHs) and to report that their homes have features that enhance wind damage resistance, such as special straps or tie-downs, anchoring, brick skirting, and metal roofing. Complicating matters further, improper installation and anchoring of units and unreinforced home additions such as covered porches and carports are often implicated as culprits for observed tornado damage, even in HUD code manufactured homes (Simmons and Sutter 2008; Roueche et al. 2019).

There is also precedent from research in the hurricane context for consideration of public perceptions and beliefs about structural safety. For example, MHRs displayed a greater propensity to evacuate than persons living in site-built homes in several studies (Huang et al. 2016; Sadri et al. 2017; Meyer et al. 2018). Kusenbach et al. (2010) researched preparedness and evacuation intentions with MHRs in the Tampa Bay, Florida, area; they noted that many participants lived in MHs built prior to enactment of stricter building codes and lacked physical reinforcements. However, Kusenbach (2017) reported that many of these same Florida MHRs expressed minimal concern about potential impacts from hurricanes due in part to confidence that their homes would be able to withstand strong winds.

Information communicated to occupants of MHs about wind hazard safety and recommended actions is complex and contradictory. From the perspective of the emergency management and meteorology sectors, MHs are particularly physically vulnerable when exposed to damaging winds, and the recommendation when tornadoes threaten is for people to leave their MHs and seek shelter in a nearby sturdier building (FEMA 2019; National Weather Service 2019b). However, storm safety information available from the manufactured housing industry draws attention to the differences in wind safety between *mobile* homes and *manufactured* homes. Industry leaders such as the Manufactured Housing Institute (2018) and Clayton Homes (2019) provide information on their websites that *manufactured* homes are as safe as, or even safer than, site-built homes because of the HUD construction code. They contend that the prevailing stigma of manufactured housing as unsafe during windstorms is a legacy of damage observed to older, unregulated *mobile* homes (Clayton Homes 2019). Thus, the MH industry focuses on the relative safety of homes manufactured to HUD code and does not always provide clear tornado safety recommendations, particularly for residents living in older mobile homes.

In this study, we build on previous work to include detailed measures of MHR beliefs about the wind resistance and safety of their homes and whether these beliefs influence tornado sheltering behavior. We pose the following hypotheses:

H4: Higher values of the MH safety and wind resistance beliefs composite will be associated with 1) being more comfortable sheltering at home (H4a) and 2) a higher likelihood of sheltering within one's MH (H4b).

H5: Having more additional features on a MH will be associated with 1) being more comfortable sheltering at home (H5a) and 2) a higher likelihood of sheltering within one's MH (H5b).

c. *Negative affectivity and prior experience*

In many risk contexts, people rely on experiences and emotions to guide decisions during and after hazard events (McCain et al. 2001; Terpstra 2011; Demuth 2018). Negative affectivity refers to emotions that are accompanied by distress, discomfort, or unpleasantness (Schumer et al. 2018). Negative emotions such as fear, worry, and dread have long been understood to influence perceptions of behavioral experiences, as well as improve understanding of motivations for various behaviors (Loewenstein et al. 2001; Allen et al. 2005). For example, Demuth et al. (2016) found that higher levels of fear and worry increased evacuation intentions in a hypothetical hurricane scenario, but were also associated with lower ratings of self-efficacy. Similarly, Lim et al. (2019) noted that fear and anxiety are two of the most frequently experienced emotions during tornado warnings in the southeastern United States. Furthermore, differences in risk perception and protective behavior between males and females are thought to be partially the result of differences in perceived gender roles and norms such that men are less likely to report feeling negative emotions such as fear and worry (Kahan et al. 2007; Tyler and Fairbrother 2013). Several recent authors considered prior tornado experiences to understand risk perception and behavior, and experience was operationalized differently in every study (see Howe et al. 2014; Silver and Andrey 2014; Demuth 2018; Miran et al. 2018; Schumann et al. 2018).

In this study, we draw primarily from Demuth's (2018) efforts that conceptualized emotion and experience as multifaceted and linked. Demuth (2018) found that experiences of tornado threats (forecast but unrealized occurrences) and/or events (actual tornado occurrences) are influential for risk perception insofar as they are based on an individual's awareness of their most memorable past tornado threat or event, their personalization of risk associated with that threat/event, any intrusive mental and emotional impacts from that threat/event, and vicarious experiences resulting from their most memorable tornado threat/event. Additionally, a person's multiple prior experiences with tornado threats and events further influence these encodings through two dimensions—frequently being exposed to tornado threats and impact communication, and negative emotional responses (Demuth 2018). We conceptualize prior experiences and negative affectivity to link with protective behaviors via the personal characteristics and threat perceptions components of the PADM (Lindell et al. 2019). We assume that greater levels of negative affectivity in terms of fear, worry, and dread should be associated with being less comfortable sheltering at home and a greater inclination to evacuate to a safer location.

While the relationship between negative affectivity, risk perception, and intended protective behavior is relatively straightforward, the influence of prior hazard experience on risk perception and protective behavior can become complex when the quality and quantity of past experiences indicates to people that a hazard may not be as impactful or worrisome as was previously thought (Lindell et al. 2019). This can occur, for instance, due to near-miss experiences in which impacts experienced were less severe than expected (Dillon et al. 2011). Other studies noted that frequent prior tornado warning experience does not necessarily correspond to higher risk perception or likelihood of taking protective action such as evacuation (Chaney et al. 2013; Ash 2015). Thus, we assume in this study that greater frequency of prior experiences of merely being in a tornado warning, or of indirect experience of tornado events via news coverage, will be associated with being more comfortable sheltering within one's home and a higher likelihood of staying home rather than evacuating. When past experience has included significant impacts on one's life, this will be associated with being less comfortable sheltering within one's MH and a lower likelihood of evacuating. Based on the literature above in this section and in previous sections, we offer the following hypotheses and one overarching research question (RQ):

- H6: Higher values of negative affectivity will be associated with 1) being less comfortable sheltering at home (H6a) and 2) a lower likelihood of sheltering within one's MH (H6b).
- H7: Having prior experience of significant impacts from tornadoes will be associated with 1) being less comfortable sheltering at home (H7a) and 2) a lower likelihood of sheltering within one's MH (H7b).
- H8: More frequent prior experiences of being in a tornado warning and watching live media coverage of tornado threats will be associated with 1) being more comfortable sheltering at home (H8a) and 2) a higher likelihood of sheltering within one's MH (H8b).
- RQ1: When considered simultaneously, which independent variables among home safety and wind resistance beliefs, access to resources, prior experiences, and negative affectivity significantly influence MH residents' likelihood of sheltering from a tornado within their home?

d. *Geographic location and variability*

The hypothesized significant relationships described in the preceding sections related to likelihood of a MH resident sheltering from a tornado within their home are also expected to vary geographically across the study area. For example, social vulnerability is known to exhibit geographic variability at national, regional, and local scales (Schmidtlein et al. 2008). Social vulnerability is generally higher across Mississippi than in Alabama, and the cotton belt of southern and central Alabama exhibits a greater intersection of social vulnerability factors than the northern and coastal portions of Alabama (Emrich and Cutter 2011; Strader and Ashley 2018). In terms of the housing stock, Alabama has a greater areal density and percentage share of double-wide MHs than does Mississippi (Ash 2017), and in both states there are more stringent construction and siting standards for MHs located closer to the Gulf of Mexico (FEMA 2009). Accordingly, it is likely that perceptions of wind safety and resistance would be a more important factor in sheltering decisions in northern Alabama because of greater variability in areal house sizes farther east and less effective siting standards moving northward away from the coastline. Finally, the northern portions of the study area, particularly northern Alabama, are subject to greater tornado frequencies, intensities, and societal impacts due to tornadoes than the southern portions (Strader et al. 2019). On this basis, MH residents in northern Alabama would theoretically be more likely to report prior tornado experiences and negative affectivity. Therefore, we pose additional hypotheses and a second RQ:

- H9: The expected negative relationship between access to resources and being comfortable sheltering at home and between will vary geographically and be stronger in Alabama.
- H10: The expected positive relationship 1) between MH safety and wind resistance beliefs and being comfortable sheltering at home (H10a) and 2) between MH safety and wind resistance beliefs and likelihood of sheltering within one's MH (H10b) will both vary geographically and be stronger in Alabama.
- H11: The expected negative relationship between negative affectivity and being comfortable sheltering at home will vary geographically and be stronger in Alabama.
- RQ2: What is the influence of geographic location on MH residents' responses about being comfortable sheltering at home and the likelihood of sheltering at home from a tornado, and do the regression beta coefficients related to home safety beliefs, access to resources, prior experiences, and negative affectivity vary geographically across Alabama and Mississippi?

3. Data and methods

a. *Internet survey responses*

The mid-south United States, including the mid- to lower Mississippi River valley eastward across the Tennessee River valley, has a long history of deadly and destructive tornadoes, particularly in the northern portions of Alabama and Mississippi (see Linehan 1957; Galway 1981; Simmons and Sutter 2012). Therefore, in

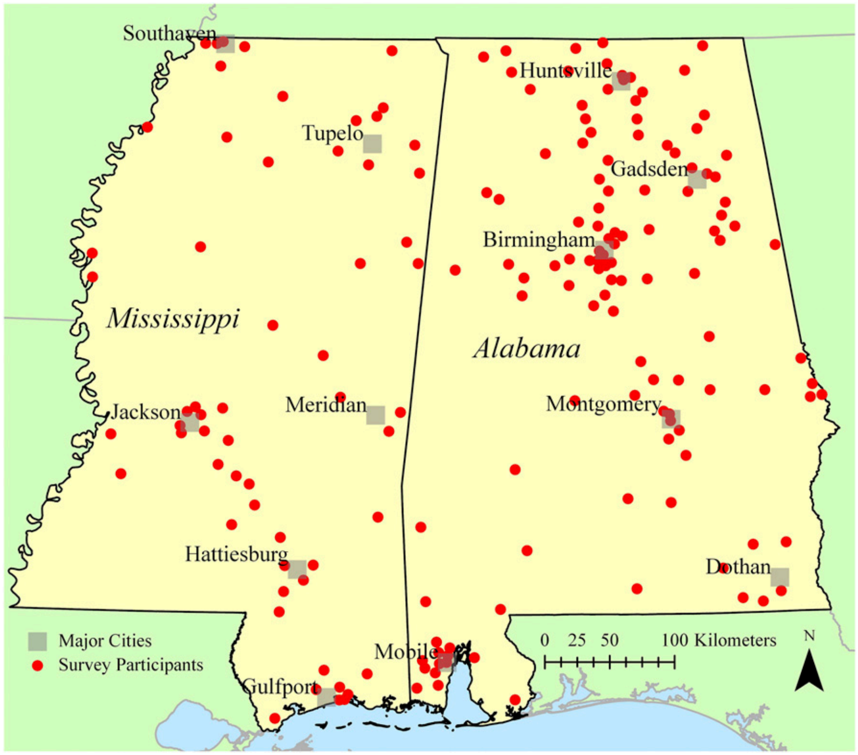

FIG. 1. Map of study area and approximate locations of survey respondents.

the spring of 2018 we recruited a total of 257 MH residents from Alabama (AL) and Mississippi (MS) to complete an internet survey via Qualtrics. After evaluation of data for incomplete responses and confirmation of respondents' locations from self-report and internet protocol (IP) address mapping, a total of 246 usable responses remained for analysis, and these were mapped using the centroid of each respondent's reported home zip code (Fig. 1). Median duration to complete the survey was 10.3 min, with a mean survey time of 12.4 min, indicating a slight skew in the data that resulted from a few longer-duration responses.

Our sample of MHRs differed from the general combined population characteristics of AL and MS in some key demographic categories. Using estimates from the American Community Survey (ACS) 5-yr dataset 2013–17 (U.S. Census Bureau 2018) as a reference, our respondents were significantly more likely to identify as female (77.2%) compared to the percentages reported in the ACS (52.3%; Table 1). In terms of age, Qualtrics survey respondents were more likely to fall in the 18- to 34-yr-old category (40%) in comparison to the ACS estimates (~30%), and were less likely to be older than 65 years (14.7%) compared to the ACS data (20%). The average respondent was 42.9 years of age (SD = 16.2) and reported ages ranged from 18 to 81 years. Our survey participants also identified as white at a higher rate than would be expected from the ACS estimates (73.6% vs 66.7%). Our sample was underrepresentative of persons who self-identified as black or African American (~21% compared to ~30% in the ACS) but had similar percentages to the ACS data for those who self-identified as Hispanic/Latino, Asian, and American Indian/Alaska Native (Table 1). Almost one-half of Qualtrics respondents over age 25 reported their highest level of educational attainment as high school/general educational development (GED) (44.4%) while 40.4% received at least an associate's, a technical, or a bachelor's degree; the latter percentage was notably much higher than reported in the ACS (~23%). Our Qualtrics survey did not have a response option to indicate attending college without obtaining a degree, hence the larger percentage who marked high school/GED in comparison with the ACS estimates. We therefore characterized the Qualtrics survey respondents as having generally higher educational attainment at the undergraduate college level than the general population of AL and MS.

At the household level, more Qualtrics respondents reported living with a spouse or partner (63%) compared to ACS estimates for AL and MS (50.6%), and similarly a higher percentage have their children living in their homes than in the ACS estimates (48% vs

TABLE 1. Demographic representativeness of Qualtrics survey respondents by gender, age, race/ethnicity, and education. Asterisks denote statistical significance levels (one asterisk: $\alpha = 0.05$; two asterisks: $\alpha = 0.01$). Here and in other tables CI indicates confidence interval.

Demographic variables	Sample estimate (90% CI)	ACS estimates 2013–17	Difference of proportions test Z value	Representative?
		Gender		
Female	77.2% ± 5.3%	52.3%	7.74**	Over
Male	22.4% ± 5.3%	47.7%	−7.86**	Under
		Age		
18–34 years	40.0% ± 5.0%	29.8%	3.35**	Over
35–54 years	32.4% ± 5.2%	33.3%	−0.29	Yes
55–64 years	12.9% ± 4.1%	16.9%	−1.60	Yes
Older than 65 years	14.7% ± 4.4%	20.0%	−1.99*	Under
		Race/ethnicity		
White alone	73.6% ± 5.0%	66.7%	2.30*	Over
Black or African American	21.1% ± 4.8%	29.5%	−2.89**	Under
Hispanic or Latino	2.0% ± 1.8%	3.0%	−0.92	Yes
Asian	1.2% ± 1.2%	1.2%	0.00	Yes
American Indian or Alaska Native	1.2% ± 0.7%	0.5%	1.56	Yes
		Highest education completed (age 25 and older)		
Less than high school	6.6% ± 3.8%	15.4%	−3.82**	Under
High school/GED	44.4% ± 4.9%	30.7%	4.66**	Over
Associate/bachelor degree	40.4% ± 4.4%	23.1%	6.44**	Over
Graduate degree	8.6% ± 3.0%	8.7%	−0.06	Yes

31.4%; Table 2). The majority of our survey respondents lived in Alabama (65.9%) with the remaining 34.1% located in Mississippi; thus, our sample was somewhat underrepresentative of Mississippi MHRs and overrepresentative of Alabama MHRs. Approximately two-thirds of respondents owned their MH units (65.6%) with the remaining reporting to be renters. While almost 40% reported their MHs were built between 1980 and 1999, this percentage is well below the estimated percentage given by the ACS estimates (61.2%). Qualtrics survey respondents who reported their MHs were built prior to 1980 or since 2010 were both overrepresented in comparison to the ACS estimates. One reason for this discrepancy could be that MHRs in the Qualtrics survey inaccurately reported the year of build for their homes; however, with no ability to verify individual responses against reference data, we proceed with caution to use the estimated years of build as reported. In total, 39.2% of respondents indicated that they worked full time, while 14.3% indicated part-time employment, and 24.1% reported they were currently unemployed. The remainder (22.4%) marked the "Other" work status category, and investigation of accompanying open-ended responses suggested that these were largely retired, disabled, or homemakers, with some identifying as students.

b. Dependent and independent variables

The first dependent variable (HomeComfortShelter; see Table 3) from the Qualtrics survey asked participants to rate their level of agreement with the statement "I feel comfortable seeking shelter in my home during a tornado," using a Likert-type interval scale where 1 indicated "strongly disagree" and 7 indicated "strongly agree." Participants tended to agree with this statement, as 55% answered in one of the three agreement categories (5–7) and 29% answered in one of the three disagreement categories (1–3; Fig. 2). The second dependent variable (ActionHomeShelter) (Table 4) asked participants to rank the likelihood of doing the protective action option "Seek shelter inside my home" among 12 additional possible actions in response to a generic hypothetical tornado warning situation described as taking place "in the middle of the day, and you had approximately 15 minutes to prepare." The majority of respondents (65%) ranked seeking shelter within the home as one of the top four most likely protective actions (Fig. 3). The variable utilizes the raw respondent rankings; therefore, lower values closer to 1 represent a greater likelihood of seeking shelter inside one's MH and higher values closer to 13 represent a lesser likelihood of remaining inside one's home for shelter from a tornado.

Nine independent variables were considered in the ordinary least squares (OLS) models. Two items pertained to participant ratings of their home's safety and wind resistance, one representing a composite of home safety and wind resistance beliefs (HomeSafetyComposite; composite

TABLE 2. Demographic representativeness of Qualtrics survey respondents by partner status, state of residence, housing tenure, and year when the MH was built. Asterisks denote statistical significance levels (one asterisk: $\alpha = 0.05$; two asterisks: $\alpha = 0.01$).

Demographic variables	Sample estimate (±90% CI)	ACS estimates 2013–17	Difference of proportions test Z value	Representative?
		Living with spouse or partner in household		
Yes	63.0% ± 5.3%	50.6%	3.89**	Over
No	37.0% ± 5.3%	49.4%	−3.89**	Under
		Living with related children under age 18 in household		
Yes	48.0% ± 4.9%	31.4%	5.61**	Over
No	52.0% ± 4.9%	68.6%	−5.61**	Under
		State of residence		
Alabama MH population	65.9% ± 5.2%	59.2%	2.14*	Over
Mississippi MH population	34.1% ± 5.2%	40.8%	−2.14*	Under
		Housing tenure		
Own MH	65.6% ± 4.7%	72.2%	−2.30*	Under
Rent MH	34.4% ± 4.7%	27.8%	2.30*	Over
		Year MH was built		
Before 1980	33.6% ± 3.8%	15.0%	8.08**	Over
1980–99	38.6% ± 5.2%	61.2%	−7.20**	Under
2000–09	18.3% ± 4.2%	19.6%	−0.51	Yes
2010–present	9.5% ± 2.1%	4.2%	4.10**	Over

of five items, Cronbach's alpha = 0.893), and one representing homes with multiple external additions that could compromise structural integrity during tornadoes (HomeAddComposite), including carports, covered porches, and extra rooms. Note that the safety and wind resistance beliefs are not absolute but are relative to other homes nearby to the respondents (Table 3). For both the information and emergency resources categories, we created composites of multiple items through summation; the information resources composite included items pertaining to smart phones, home internet access, and television, among other resources, while the emergency resource category included access to a motor vehicle, financial savings, and job security. In the psychological resources category, we employed a composite positive psychological capital variable from 12 Likert-type survey items (PsychCapitalComposite; Cronbach's alpha = 0.931), encompassing the personal psychological dimensions of hope, efficacy, resilience, and optimism (Luthans et al. 2007; Luthans and Youssef-Morgan 2017). The 12-item version of the psychological capital questionnaire was obtained from Luthans et al. (2014) and has been applied previously in a variety of cultural contexts (Wernsing 2014) and for high-stress, short-term situations (Valdersnes et al. 2017), as these positive resources can be sources of strength during challenging life situations. Finally, there were three survey items related to prior experience and three related to negative affectivity associated with tornadoes, both adapted from Demuth (2018). We generated a negative affectivity composite by summing three Likert-type responses for survey items on fear, worry, and dread (Cronbach's alpha = 0.903).

c. Statistical methods

We modeled two dependent variables pertaining to survey participants' potential to take shelter within their MHs during tornado warnings. To address RQ1, we used OLS regression to test a suite of independent variables related to beliefs about home safety and wind resistance, available psychological and tangible resources, prior tornado experience, and negative affectivity for significant relationships with the two dependent variables. In preliminary analyses, we considered other model types (such as ordinal regression and generalized linear models) but chose OLS regression to compare results of the aspatial OLS models with explicitly spatial results using geographically weighted linear regression (GWR). We then used GWR for RQ2 to explore how statistical relationships between our dependent and independent variables vary spatially (see Wheeler 2014 for a primer on GWR). The GWR models were run using an adaptive distance kernel that performed local regression for each participant's location using the 115 nearest neighbors. The bandwidth of 115 neighbors was determined through the golden search method provided in the GIS software to maximize variance explained in the spatially varying regression coefficients. Last, we mapped the GWR coefficients simultaneously with the local pseudo-t values to show both the direction of the relationships and confidence in these estimates (as recommended by Matthews and Yang 2012). Statistical and geospatial analyses were completed using the softwares SPSS (version 25) and ArcGIS Pro 2.3.3.

4. Results

a. Regression model OLS1 and H1a–H8a

Regression model OLS1 (Table 5) was significant and accounted for about 51% of the variance in the dependent variable (HomeComfortShelter). While the OLS1 model standardized residuals did not approximate a normal distribution as indicated by the result of a Kolmogorov–Smirnov test (KS statistic = 0.072; p value = 0.003), they were symmetrically distributed about a mean of zero with a standard deviation of 0.98. Only two variables were significant predictors of participants' stated level of agreement with feeling comfortable seeking shelter in their home during a tornado in model OLS1. Those who rated their homes as safer and more wind resistant indicated being more comfortable with the idea of sheltering at home, providing evidence to support H4a. Those who expressed greater negative affectivity (fear, worry, and dread) in relation to tornadoes were less comfortable with the prospect of sheltering at home, in support of H6a. Results suggested that participants who stated they have greater access to emergency resources may have been more comfortable sheltering at home, which if true would run counter to H2a. However, this result was not significant at the nominal significance level of $\alpha = 0.05$. The remaining hypotheses (H1a, H3a, H5a, H7a, and H8a) were rejected because of lack of statistical significance of the corresponding independent variables in model OLS1.

b. Regression model OLS2 and H1b–H8b

Model OLS2 was also statistically significant, but only accounted for about 7% of the variance in the dependent variable (ActionShelterHome) (Table 6). OLS2 model residuals again did not approximate a normal distribution (KS statistic = 0.127; p value < 0.001) and though the mean was zero and standard deviation near one, the residuals exhibited positive skew with systematic overestimation of the dependent variable. Only one independent variable was significant in model OLS2. Respondents who rated their homes as safer and more wind resistant ranked sheltering inside their home as one of the protective behaviors they would most likely engage in during a hypothetical tornado warning received in the middle of the day with 15 min to prepare. This result provides evidence in support of H4b. The remaining hypotheses (H1b, H2b, H3b, H5b, H6b, H7b, and H8b) were all rejected because of a lack of statistical significance of the corresponding independent variables in model OLS2.

c. Geographically weighted regression model GWR1 and H9, H10a, and H11

Prior to the GWR analyses, the two dependent variables (HomeComfortShelter and ActionShelterHome) were analyzed for geospatial patterns. Spatial autocorrelation tests (Global Moran's I statistic) showed no evidence of significant spatial clustering or dispersion across a wide range of distance bandwidths. Additional analyses also did not find significant associations between the dependent variables and participant-reported estimates of housing density, nor with latitude. The only geographic pattern of note was that one dependent variable (ActionShelterHome) was significantly negatively correlated with longitude (Kendall's tau-b = -0.104; significance p value = 0.024); thus, participants living in the eastern portions of the study area more often ranked sheltering inside their home as one of the protective behaviors they would most likely engage in, given the hypothetical tornado warning scenario.

The final statistical procedures investigated spatial variability in the relationships between the two dependent variables and the three independent variables that were significant (or marginally significant in the case of the emergency resources variable from OLS1) predictors in models OLS1 and OLS2. The first geographically weighted regression model (GWR1) used three variables (HomeSafetyComposite, EmerResourceComposite, and TornNegAffectComposite) to predict HomeComfortShelter. Regression coefficients for HomeSafetyComposite were significantly positive across all of Alabama and Mississippi (Fig. 4a). However, the results displayed evidence that the positive relationship between home safety and wind resistance beliefs and being comfortable sheltering from a tornado at home was somewhat more pronounced particularly in the northern portions of the study area in comparison to central areas near Jackson, MS, Tuscaloosa, AL, and Montgomery, AL. This result provided partial evidence to support H10a; however, the relationship was significant and consistently positive across the entire study area.

Coefficients for the remaining two predictors were more geographically varied; the emergency resources composite was significant and positive mainly in northern AL to the north and east of the Birmingham, AL, metropolitan area (Fig. 4b). This result provided evidence counter to H9; there is geographic variation, but the relationship is significantly positive rather than negative. The results suggest that access to emergency

TABLE 3. Variable description, variable name, measurement level, and descriptive statistics for dependent variables and independent variables used in this study, including items used to construct composite variables.

Variable description	Variable name	Measurement level	Mean value or percentage
	Dependent variables		
"I feel comfortable seeking shelter in my home during a tornado"	HomeComfortShelter	Interval from 1 = strongly disagree to 7 = strongly agree	4.43
Ranking among 13 choices of most likely tornado warning protective action for item "Seek shelter inside my home"	ActionShelterHome	Interval with possible range from 1 to 13; values closer to 1 denote greater likelihood to shelter within MH	4.13
	Independent variables		
Home safety and wind resistance beliefs variables			
"Compared to others around me, my home is better anchored to the ground"	HomeBetterAnchor	Interval from 1 = strongly disagree to 7 = strongly agree	4.30
"Compared to others around me, my roof is in better condition"	RoofBetter	Interval from 1 = strongly disagree to 7 = strongly agree	4.39
"Compared to others around me, my home is less likely to tip over"	LessLikelyTip	Interval from 1 = strongly disagree to 7 = strongly agree	4.57
"Compared to others around me, my home offers more protection from flying debris in a tornado"	MoreDebrisProtection	Interval from 1 = strongly disagree to 7 = strongly agree	4.33
"My home is larger than those around me"	HomeLarger	Interval from 1 = strongly disagree to 7 = strongly agree	3.76
Sum of five home safety/wind resistance belief items above	HomeSafetyComposite	Interval with possible range from 5 to 35; greater values indicate greater perceived home safety and wind resistance	21.36
Home addition variables			
"Does your home have any of the following features? carport"	Carport	Binary: 1 = yes; 0 = no	22% yes
"Does your home have any of the following features? covered front porch"	CoveredFrontPorch	Binary: 1 = yes; 0 = no	46% yes
"Does your home have any of the following features? covered porch (back or side)"	CoveredBackPorch	Binary: 1 = yes; 0 = no	29% yes
"Does your home have any of the following features? addition (extra room)"	ExtraRoom	Binary: 1 = yes; 0 = no	19% yes
Sum of four home addition items above	HomeAddComposite	Interval with possible range from 0 to 4; greater values indicate multiple additions to home	1.16
Information resources			
"Do you have a smart phone (either android, iphone, or other) with internet on it?"	HaveSmartPhone	Binary: 1 = yes; 0 = no	89% yes
"Do you have internet access at home?"	HaveHomeInternet	Binary: 1 = yes; 0 = no	89% yes
"Do you have a television that has cable in your home?"	HaveTVCable	Binary: 1 = yes; 0 = no	70% yes
"Do you have a land-line phone?"	HaveLandLine	Binary: 1 = yes; 0 = no	42% yes
"Are you able to hear tornado sirens at your home?"	HaveHearTornadoSiren	Binary: 1 = yes; 0 = no	81% yes
Sum of five information resources items above	InfoResourcesComposite	Interval with possible range from 0 to 5; greater values indicate better access to information resources	3.70
Emergency resources			
"I have access to a reliable vehicle"	HaveReliableCar	Interval from 1 = strongly disagree to 7 = strongly agree	5.92

TABLE 3. (*Continued*)

Variable description	Variable name	Measurement level	Mean value or percentage
"I have enough savings on hand to deal with an emergency that made me miss work for a few days, like if a tornado were coming"	HaveSavings	Interval from 1 = strongly disagree to 7 = strongly agree	4.18
"I have enough flexibility at my work that I can take time off to deal with emergencies, like if a tornado were coming"	HaveWorkFlexibility	Interval from 1 = strongly disagree to 7 = strongly agree	4.74
Sum of three emergency resources items above	EmerResourcesComposite	Interval with range from 3 to 21; greater values indicate better access to emergency resources	14.83
Psychological capital			
"I can usually think of a way to get myself out of a jam"	QuickThink	Interval from 1 = strongly disagree to 7 = strongly agree	5.46
"I see myself as being pretty successful"	Successful	Interval from 1 = strongly disagree to 7 = strongly agree	4.93
"I can think of many ways to reach my current goals"	ManyGoalSolutions	Interval from 1 = strongly disagree to 7 = strongly agree	5.13
"I am looking forward to the life ahead of me"	LookForwardLife	Interval from 1 = strongly disagree to 7 = strongly agree	5.54
"The future holds a lot of good in store for me"	FutureGood	Interval from 1 = strongly disagree to 7 = strongly agree	5.51
"Overall, I think more good things will happen to me than bad things"	GoodThingsHappen	Interval from 1 = strongly disagree to 7 = strongly agree	5.42
"I can make myself do work I do not want to do"	WorkResolve	Interval from 1 = strongly disagree to 7 = strongly agree	5.61
"I can usually find my way out of a difficult situation"	SolveDifficulty	Interval from 1 = strongly disagree to 7 = strongly agree	5.44
"It is okay if there are people who don't like me"	OKNotLikeMe	Interval from 1 = strongly disagree to 7 = strongly agree	5.93
"I am confident that I could deal efficiently with unexpected events"	DealUnexpected	Interval from 1 = strongly disagree to 7 = strongly agree	5.40
"I can solve most problems if I try hard enough"	SolveProblems	Interval from 1 = strongly disagree to 7 = strongly agree	5.77
"I can remain calm when facing difficult situations"	KeepCalm	Interval from 1 = strongly disagree to 7 = strongly agree	5.33
Sum of 12 psychological capital variables above	PsychCapitalComposite	Interval with possible range from 12 to 84; greater values indicate greater psychological capital	65.47
Tornado experience and negative affectivity			
"I have been in a tornado warning"	BeenInWarning	Interval from 1 = strongly disagree to 7 = strongly agree	6.26
"I have heard or watched news coverage about a tornado as it was happening"	SeenLiveTornadoNews	Interval from 1 = strongly disagree to 7 = strongly agree	6.15
"Have you ever had a tornado significantly impact your life?"	TornadoSigImpactLife	Binary: 1 = yes; 0 = no	37% yes
"Thinking about a tornado makes me feel a sense of dread"	TornadoDread	Interval from 1 = strongly disagree to 7 = strongly agree	5.22
"Thinking about tornadoes makes me feel fear"	TornadoFear	Interval from 1 = strongly disagree to 7 = strongly agree	4.95
"Thinking about tornadoes makes me feel worried"	TornadoWorry	Interval from 1 = strongly disagree to 7 = strongly agree	5.13
Sum of three tornado negative affectivity variables above (dread, fear, and worry)	NegTornAffectComposite	Interval with possible range from 3 to 21; greater values indicate greater negative affectivity related to tornadoes	15.3

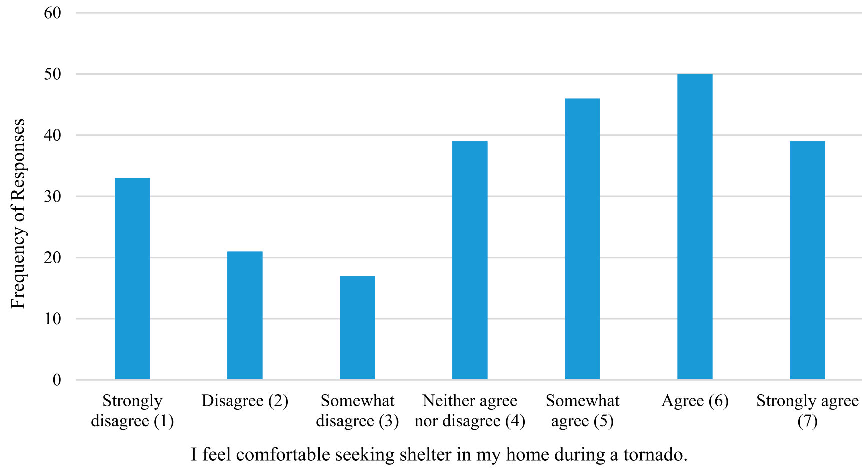

FIG. 2. Distribution of responses for dependent variable HomeComfortShelter.

resources—such as a reliable motor vehicle and financial savings—was perhaps unrelated to feeling comfortable with sheltering from tornadoes at home for participants in northwestern MS and southeastern AL. Negative affectivity associated with tornadoes (fear, worry, and dread) was significantly negatively associated with HomeComfortShelter primarily across the northern third of the study area (Fig. 4c), which supported H11. This relationship was much weaker in central and south-central AL and MS, especially near Jackson.

d. *Geographically weighted regression model GWR2 and H10b*

The second model (GWR2) used the only significant predictor from OLS2 (HomeSafetyComposite) to predict the variable ActionShelterHome. Home safety and

TABLE 4. List of 13 choices and mean ranks that were given to participants for ranking protective actions they would be most likely to do if they received a tornado warning for their area, with 1 being the most likely and 13 being the least likely.

Variable description	Measurement level	Mean ranking
"Seek shelter inside my home"	Interval with 1 = most likely to do and 13 = least likely to do	4.13
"Attempt to seek shelter away from my home"	Interval with 1 = most likely to do and 13 = least likely to do	6.30
"Pray"	Interval with 1 = most likely to do and 13 = least likely to do	5.22
"Go outside and look for the storm"	Interval with 1 = most likely to do and 13 = least likely to do	7.93
"Bring the children inside"	Interval with 1 = most likely to do and 13 = least likely to do	4.00
"Bring the pets inside"	Interval with 1 = most likely to do and 13 = least likely to do	4.96
"Gather supplies from around the house"	Interval with 1 = most likely to do and 13 = least likely to do	6.53
"Contact loved ones and neighbors on the phone"	Interval with 1 = most likely to do and 13 = least likely to do	7.43
"Move vehicles away from trees"	Interval with 1 = most likely to do and 13 = least likely to do	8.25
"Move outside belongings (lawn furniture, grills, etc)"	Interval with 1 = most likely to do and 13 = least likely to do	8.98
"Go online to get more information about the storm"	Interval with 1 = most likely to do and 13 = least likely to do	8.65
"Turn on the television to get more information about the storm"	Interval with 1 = most likely to do and 13 = least likely to do	7.24
"Go physically check on a neighbor/loved one"	Interval with 1 = most likely to do and 13 = least likely to do	11.40

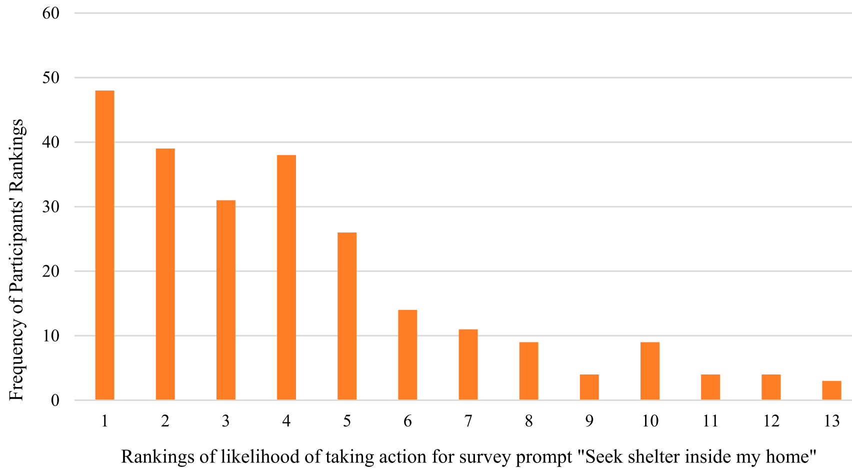

FIG. 3. Distribution of responses for dependent variable ActionShelterHome.

wind resistance beliefs were associated with higher rankings (meaning lower numerical values toward 1) of sheltering at home as a potential tornado protective behavior across most of the study area, with particular emphasis in far southern and far northeastern locations near Mobile, AL, Gulfport, MS, and Huntsville, AL (Fig. 5). The exception to this was a swath from northwestern MS to southeastern AL, where this negative association was less pronounced. The results provided evidence in support of H10b.

5. Discussion and study limitations

a. *Research question 1 and H1–H8*

In relation to RQ1, the OLS regression models provided evidence that—when considered simultaneously with all independent variables—only home safety and wind resistance beliefs together with negative affectivity significantly influenced MH residents' likelihood of sheltering from a tornado within their home. Model OLS1 performed relatively well to predict respondents' agreement with how comfortable they would feel sheltering within their homes from a tornado, while the other model (OLS2) performed poorly. The reason for this disparity is likely that the latter dependent variable was much more specific and was presented alongside a wider range of potential responses for protective and preparedness behaviors. Also, a more sophisticated model specification beyond a multivariate linear function (for OLS2) might yield slightly better results for prediction of MHRs' ranking of sheltering from a tornado within their home relative to the other protective behavior choices. The disparity in model performance here serves as another reminder that understanding of how vulnerability factors and threat and response beliefs translate to specific intended and actual protective behaviors remains an elusive task because of the wide variety of potential facilitating and constraining personal and situational factors, as shown in the PADM (Lindell et al. 2019).

Hypotheses 1a–3a pertaining to resource access were not supported by the regression results. The emergency resources variable that included access to a motor

TABLE 5. Results for model OLS1 with dependent variable HomeComfortShelter. Asterisks denote statistical significance levels (one asterisk: $\alpha = 0.05$; two asterisks: $\alpha = 0.01$).

Independent variable names	Unstandardized beta coef	*t* values	*p* values	Variance Inflation Factor
OLS1: $N = 246$, adjusted $R^2 = 0.513$, $F = 29.65$, and p value < 0.001				
HomeSafetyComposite	0.170	13.246	< 0.001**	1.256
HomeAddComposite	0.049	0.557	0.578	1.049
InfoResourcesComposite	0.025	0.302	0.763	1.115
EmerResourcesComposite	0.039	1.804	0.072	1.308
PsychCapitalComposite	0.001	0.151	0.880	1.419
BeenInWarning	−0.021	−0.272	0.786	1.451
SeenLiveTornadoNews	0.076	0.945	0.346	1.583
TornadoSigImpactLife	0.099	0.520	0.603	1.106
TornNegAffectComposite	−0.068	−3.495	0.001*	1.046

TABLE 6. Results for model OLS2 with dependent variable ActionShelterHome. Asterisks denote statistical significance levels (one asterisk: $\alpha = 0.05$; two asterisks: $\alpha = 0.01$).

Independent variable names	Unstandardized beta coef	t values	p values	Variance inflation factor
OLS2: $N = 240$, adjusted $R^2 = 0.065$, $F = 2.831$, and p value = 0.004				
HomeSafetyComposite	−0.116	−4.290	<0.001**	1.273
HomeAddComposite	0.032	0.172	0.863	1.053
InfoResourcesComposite	0.063	0.359	0.720	1.126
EmerResourcesComposite	0.011	0.234	0.815	1.353
PsychCapitalComposite	−0.004	−0.226	0.821	1.440
BeenInWarning	0.072	0.446	0.656	1.449
SeenLiveTornadoNews	−0.057	−0.338	0.736	1.584
TornadoSigImpactLife	0.241	0.600	0.549	1.116
TornNegAffectComposite	−0.061	−1.497	0.136	1.050

vehicle, having adequate financial savings, and having the flexibility to miss work if necessary was not significant at the 0.05 alpha level, but did have a p value of less than 0.1 in OLS1. However, the expectation was for a negative relationship with the dependent variables, yet OLS1 results showed a positive beta coefficient. Whereas Ash (2015) found in South Carolina that having access to a functioning vehicle was associated with being more likely to evacuate, this study's results do not support this assumption. The discrepancy may be due to grouping of vehicle access together with financial savings and ability to leave work in the emergency resources composite; this variable may have acted as a proxy for income and obscured the importance of access to a functioning vehicle for evacuation decisions. The regression results did not provide any evidence that access to information resources or psychological capital were significant factors related to feeling comfortable sheltering within one's MH.

The OLS regression results provided strong evidence in support of H4a and H4b. The composite independent variable representing home wind resistance and safety beliefs was positively associated with the dependent variables and highly significant in both OLS models. The implication of this finding is that people who believe their MH is safer and more wind resistant are predisposed to shelter in place rather than evacuate elsewhere. We cannot say for certain whether the qualities included in this study—MH siting, anchoring, exterior materials, and the size of the home—encompass all relevant factors that compose these safety beliefs. Still, these findings align well with similar recent findings highlighting how greater safety beliefs and confidence in MH construction quality tend to lessen risk perception and the likelihood of evacuation among MHRs (Ash 2015, 2017; Kusenbach 2017). Hypotheses 5a and 5b were not supported as the second predictor variable capturing additions to MHs such as porches, carports, and extra rooms was not significant in either model. However, it may be that any perceived additional wind resistance gained via these added home features was sufficiently captured by the home safety composite variable. The strong predictive power of the safety and wind resistance beliefs variable in this study may be due in part to oversampling of participants who own their MH. If the study included a greater share of MH renters, the significance of this variable could be reduced because renters might not express as strong a sense of pride or safety in their dwelling as owners do. A future study focusing specifically on the relationships between MH safety beliefs, home tenure, and feelings of pride and place attachment would be valuable.

Results were mixed with respect to H6 and H7; H6a was supported in OLS1, whereas H7 was not supported in either model. For H6a, we found negative affectivity—represented as a combination of fear, worry, and dread—to be significantly negatively associated with respondent levels of agreement about feeling comfortable with the idea of sheltering at home (OLS1). In simpler terms, MH residents who feel fear, worry, and dread when thinking about tornadoes may be more inclined to shelter somewhere other than inside their home. This is consistent with recent findings of the importance of fear and worry for increasing risk perception and likelihood of engaging in protective behaviors (Demuth et al. 2016; Demuth 2018; Lim et al. 2019). However, this result was not consistent across both OLS models as negative affectivity was not significant in OLS2; the p value of 0.136 suggests that perhaps a significant relationship was not detected due to insufficient power, measurement error, or sampling error. As for H7 and H8, there was no evidence from the OLS models that prior experience with tornadoes, as operationalized in this analysis, influences whether one is comfortable taking shelter within their MH or how sheltering in their MH ranks among several possible protective behaviors. This provides another piece of evidence corroborating previous findings by Chaney et al. (2013) and Ash (2015)

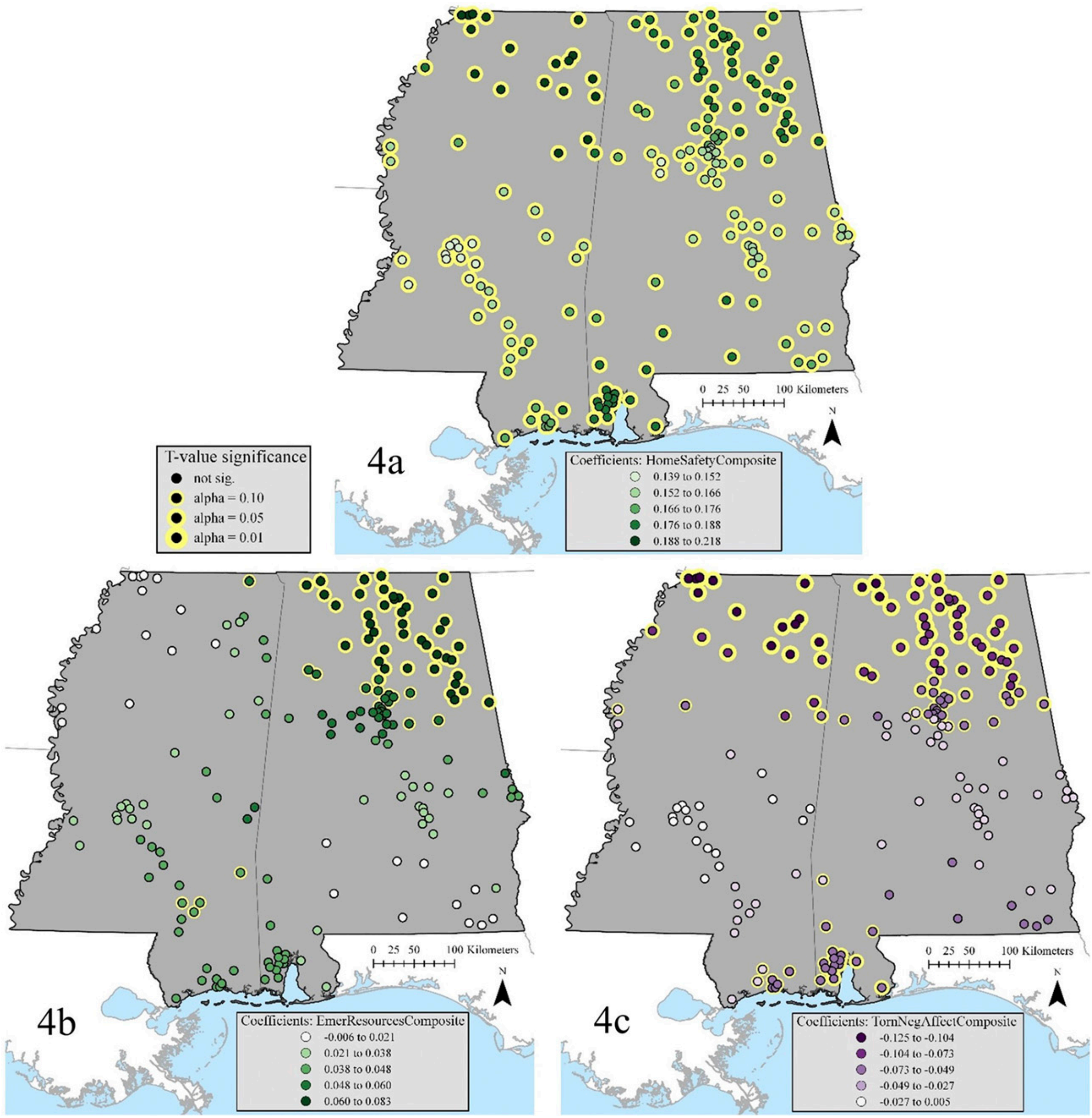

FIG. 4. Coefficients and variable significance (based on *t* values) for geographically weighted regression of three independent variables from model GWR1 with dependent variable HomeComfortShelter.

that frequency of past experiences with tornadoes does not necessarily correspond to greater risk perception or propensity for evacuation from a MH. It is possible that the significance of negative affectivity could be overestimated due to the disproportionately low percentage of male respondents and the tendency for men—especially white men—to downplay negative affect in risk perception and evacuation studies (Kahan et al. 2007; Tyler and Fairbrother 2013). Another caveat here is that evacuation decisions are often a household event, and the characteristics and emotions of one household respondent do not necessarily represent the characteristics and affective states of others in the household.

b. *Research question 2 and H9–H11*

The GWR results provided strong evidence that beta coefficients related to home safety beliefs vary geographically across Alabama and Mississippi, and partial

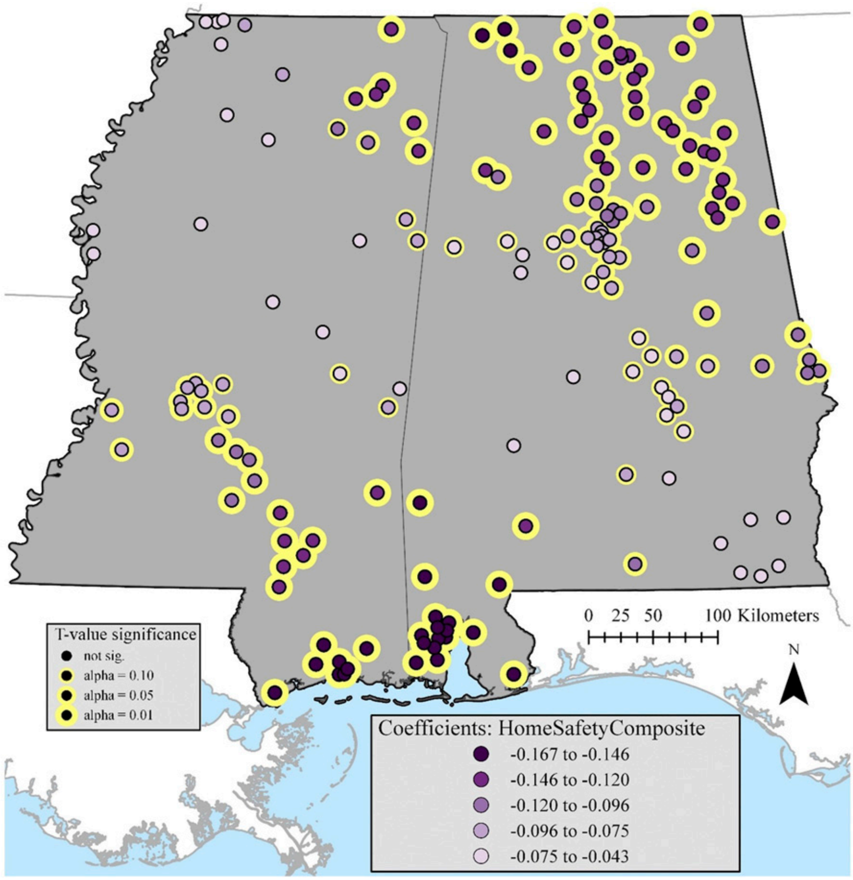

FIG. 5. Coefficients and variable significance (based on *t* values) for geographically weighted regression of independent variable from model GWR2 with dependent variable ActionShelterHome.

evidence of significant geographic variation of beta coefficients for emergency resource access and negative affectivity. Hypothesis 9 was not supported because the emergency resources composite was a significant predictor of feeling *more* comfortable sheltering at home rather than *less* comfortable. This is suggestive of a regional MH vulnerability and perception paradox in portions of the study area: in northeastern Alabama, those who have the means to evacuate elsewhere perceive less of a need to do so, while those who recognize the potential peril of sheltering in their MH—and may prefer not to do so—lack the resources to carry out a more desirable sheltering plan. The paradox is similar to that observed in the flood context by Wachinger et al. (2013), with access to resources being a key factor and that MHRs who live in larger and newer units are likely to shelter at home despite being aware of the risks. The most notable difference compared to Wachinger et al. (2013) is that this study did not assess whether MHRs feel personally responsible for tornado protective action; our results did suggest, however, that positive psychological capital (which included a self-efficacy component) was not a significant predictor of the propensity to shelter at home.

Hypothesis 10a was partially supported by the GWR results. In GWR1, MH safety and wind resistance beliefs were significantly positively associated with feeling comfortable sheltering at home across the entire study area. This demonstrates the critical importance of home safety and wind resistance beliefs for tornado sheltering behaviors, although GWR2 (H10b) results suggest greater regional importance for participants very near the coast in southern Alabama and Mississippi, as well as in the northern third of the study area. This corresponds somewhat to the expected geographic pattern, likely due in part to increased prevalence of larger MHs in northern Alabama and enhanced construction and siting standards enforced in the high wind hazard zones just inland from the Gulf of Mexico in southern AL and MS (FEMA 2009).

Last, the geographic pattern of the relationship of negative affectivity on attitudes toward sheltering at home suggests this is a crucial consideration in areas more exposed to tornadoes (northern AL and MS) and tropical cyclones (coastal areas near Mobile and Biloxi, MS) (H11). From this result, we would expect anxiety about storms to influence greater demand for tornado evacuation options to get out of MHs in Huntsville; Birmingham; Gadsden, AL; Tupelo, MS; Southaven, MS; and Mobile in comparison with Jackson; Meridian, MS; Montgomery; Auburn–Opelika, AL; and Dothan, AL. This result is consistent with the well-known history of intense and damaging tornadoes concentrated in northern portions of both AL and MS (Ash 2017; Strader et al. 2019).

c. Study limitations

Several study limitations warrant mention here. The size, geographic scope, and sociodemographics of our sample of participants limited the ability to make definitive conclusions. Demographically, we oversampled women and homeowners and did not receive enough responses from Latina/o respondents to draw conclusions relevant for this growing population in the study area. The intersection of Spanish-speaking populations with MHs in tornado-prone locations of the United States remains an important gap for future data collection and investigation. A larger and more geographically expansive sample would enhance the ability to identify geographic variations in tornado vulnerability across the entire southeastern United States and would allow for increased power in statistical models to identify marginally significant effects. Data on sheltering behaviors of MHRs associated with actual tornado events or threats are needed to validate hypothetical intention-based studies. A reliable multiple-item measure for self-efficacy and response efficacy in shelter and evacuation behavior would enhance both hypothetical and postevent studies. Another area that could be improved is the wording of questions posed as hypothetical scenarios using phrases such as "during a tornado." It would be clearer and allow for easier interpretation of responses to specify whether this refers to being within a tornado warning polygon or refers to seeing the actual effects of a tornado. Finally, although the general psychological capital composite was not significant in our analyses, future work in this area could prove more fruitful by focusing the psychological capital items to be more specific to the tornado context and by breaking down the positive psychological capital measure into more specific indicators of individual capacities for hope, efficacy, resilience, and optimism.

6. Conclusions

This study provided several key findings that advance understanding of tornado sheltering decisions among MH residents in Alabama and Mississippi. The first key finding was that approximately one-half of the MHRs who completed the questionnaire reported that they would feel comfortable sheltering inside their MH during a tornado. This presents a challenge for tornado safety recommendations because a large portion of the target audience is predisposed not to carry out the recommended action to shelter elsewhere. This also echoes previous findings of hesitation by MH residents to seek shelter in a nearby ditch rather than inside the home (Schmidlin et al. 2009). The second key finding was that the unwillingness to evacuate to sturdy shelter occurs at least partially because MH residents tend to rate their homes and their features as relatively safe and wind resistant. While this relationship is significant across the study area, it is particularly strong in northern and eastern portions of Alabama where there tend to be larger MHs. The third major finding in this study was that negative affectivity in terms of fear, worry, and dread was associated with higher likelihood of evacuating MHs. This relationship is particularly pronounced in northern Alabama where tornadoes have occurred frequently and with devastating results over the past 50 years. Last, the fourth key finding was that greater access to emergency resources was associated with a higher likelihood of sheltering inside one's home. While this result did not follow our hypothesis about the direction of the relationship, it suggested a vulnerability paradox in which those who had the means to evacuate to a sturdy building were not convinced they needed to do so, while those who were motivated to evacuate for shelter could not do so because of lack of appropriate resources. An important avenue for investigation could be to determine how many MH residents have a well-defined evacuation plan and how such specific planning might counteract some of influential factors identified in this study.

By identifying several significant predictors of the likelihood for MH residents to shelter from tornadoes in their MH, this study provided insights into how National Weather Service forecasters, emergency managers, and media partners in AL and MS might communicate more effectively with MHRs about tornado safety and response recommendations. We acknowledge there are myriad factors influencing whether MH residents shelter at home or away from the home, such as whether the event occurs during nighttime, or whether there is a reachable alternative sheltering location. Still, roughly half of MHRs are likely to be skeptical about evacuation for tornadoes, at least partially because they believe their home may be able to withstand tornadic winds and debris. Therefore, regular reminders for residents to check on specific MH components that are key for wind safety (anchoring components, roofing, etc.) will help some residents to discover structural deficiencies and either address them via repair or by altering their sheltering plans accordingly. Strong tornadoes (EF3+) destroy well-constructed and correctly anchored MHs, but communication that prompts preparedness and mitigation actions can be crucial to enhance survival chances for most tornadoes. Some of the most socially vulnerable MHRs will want to evacuate when tornadoes threaten, but have difficulty doing so because of a lack of resources. Effective messaging in the days and hours prior to a potential tornado threat will encourage people to communicate with and assist their friends, family, and neighbors who live in MHs to shelter elsewhere if they so desire. For MH residents who experience strong negative affectivity when tornadoes threaten and are more likely to evacuate, messaging can highlight clearly how evacuation can be most effective when it is done before potentially tornadic storms arrive, avoiding the stress and danger of trying to prepare and move to sturdy shelter in the midst of inclement weather.

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