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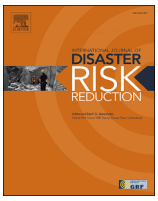

Understanding the dynamic process of human behavior changes towards disaster preparedness: An application of the integrated TTM with SCT and PMT

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ABSTRACT

Integrating the Transtheoretical Model with Social Cognitive Theory and Protection Motivation Theory, we propose a new model to study the progress of behavior changes towards disaster preparedness along three developmental stages: from "not prepared" (NP), to "intention to prepare" (IP), to "already prepared" (AP). Using the 2021 National Household Survey data (FEMA, N = 6,180), we tested this model by employing a series of nested weighted generalized ordered logistic regressions. We found that, although Hispanics have a larger prevalence of IP than their non-Hispanic white counterparts, they are less likely to move to the AP stage. The observed ethnic disparity is largely due to the disparities in actual behavioral capabilities in essential knowledge and access to resources between the two groups. Personal disaster experience, social/observational learning, self-efficacy, and risk perception each facilitate behavior changes from the NP to IP or AP stage (i.e., departure from NP stage) and from NP or IP stage to AP stage (i.e., arrival at AP stage). Although income does not necessarily influence one's decision to depart from the NP stage, it determines one's arrival at the AP stage. Increasing one's income further boosts the realization of AP for people with high-risk perceptions. However, for people with moderate or low levels of risk perceptions, increased income did not lead to arrival at the AP stage. Additional research is needed to more fully apply this process-oriented approach with new measurement introduced in this paper to study the behavior changes among subpopulations in exposure to specific hazards.

1. Introduction

Over the past 70 years, the annual frequency of natural disasters worldwide has increased by more than 11 times, from 37 in 1953 to 413 in 2023 [1]. The threat posed by these natural disasters to human life is unprecedentedly severe—a recent study suggests that the five natural disasters causing the highest number of total deaths and injuries worldwide all occurred in the past 20 years [2]. Although emergency planning and the action of disaster preparedness play vital roles in protecting human life and mitigating the risk of property loss or damage caused by disasters [3,4], the mechanism of human behavior change towards disaster preparedness has not been fully explored.

Disaster preparedness can be defined as a protective behavior that occurs when individuals take measures to prepare for potential, future disasters and mitigate their impacts on vulnerable populations [5]. Accordingly, behavior change theories such as Social Cognitive Theory (SCT) [6] and Protection Motivation Theory (PMT) [7] have been applied to study human behavior in dichotomous

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change (i.e., moving from "not prepared" to "prepared" status) in relation to a series of risk and protective factors [8–11]. Nevertheless, individual preparedness is more appropriately conceptualized as a dynamic process rather than a binary change. This study integrates the transtheoretical model (TTM) with SCT and PMT and analyzes 2021 National Household Survey data [12] with the aim of providing an overview of individual behavior changes towards disaster preparedness along three developmental stages: from "not prepared" (NP), to "intention to prepare" (IP), to "already prepared" (AP) and illustrating how this dynamic decision-making process is related to key elements in SCT and PMT.

2. Literature review

2.1. Perceived preparedness and actual preparedness

Previous studies approached disaster preparedness using two distinct concepts—perceived preparedness (subjective measurement) and actual preparedness (objective measurement)— that may or may not be related. For example, Basolo et al. [13] found people with higher levels of perceived preparedness tended to have higher levels of actual preparedness in Los Angeles and New Orleans, cities where residents were routinely exposed to two types of natural disasters: earthquakes and hurricanes, respectively. Their study also found that individual feelings about governmental efficacy played different roles in these two distinct forms of preparedness. For example, confidence in local government to manage a disaster is positively associated with perceived preparedness, but not with actual preparedness. A recent survey study conducted in Rio Grande Valley, Texas (N = 526), suggested more than 40 % of respondents thought they would but did not act for disaster preparedness, while only 8 % achieved consistency between their thoughts and actions [14]. Based on a systematic review of 69 papers regarding household disaster preparedness in 26 countries, Brown [15] reported a significant positive relationship between perceived preparedness and actual preparedness.

2.2. A dynamic process of disaster preparedness

Rather than the two distinct concepts discussed above, individual disaster preparedness is more appropriately conceived of as a dynamic process that at least involves the transition from the mental activity of having an intention for preparedness to taking action to prepare. Vinnell et al. [16] found that, among a small sample of 61 study participants in Wellington, New Zealand, intention to prepare for natural disasters positively predicted their preparation behaviors. This indicates that individual behavioral changes towards disaster preparedness may occur along a developmental stage: from "not-prepared" stage, to "have an intention" stage, then ultimately to the stage of "action of preparedness".

However, humans do not always act in accordance with their behavioral intentions [13]. For example, based on PMT, Tang and Feng [17] argued that behavioral intent and actual disaster preparedness behavior might or might not be related. Informed by SCT, Paton [18] postulates that while some risk/protective factors (such as self-efficacy) are influential at forming a behavioral intention, they do not necessarily play a role at the stage when intention is translated into action. Nevertheless, the field lacks a holistic model that integrates both PMT and SCT with a consistent measurement to quantify this dynamic process, whereby personal, social, and environmental determinants of human behavioral transition from one stage to another. This study integrates the Transtheoretical Model ([19–21]; as detailed below) with SCT and PMT to provide a new framework to gauge these dynamics and examine individual behavioral transitions to determine whether they occur in ascending order in relation to a series of risk and protective factors.

2.3. The Transtheoretical Model

The Transtheoretical Model (TTM) developed by Prochaska and DiClemente [20] is a health psychology framework that focuses on the individual decision-making process for behavior change. TTM, which operates on the assumption that people do not change behaviors quicky and conclusively, asserts that changes to individual health behavior usually moves along at least three ordered, developmental stages: from the precontemplation stage (in which people are often not aware a problem exists and do not intend to take action to change their behaviors), to the contemplation stage (in which people are aware that a problem exists and intend to change), and finally to the action stage (during which people change their behavior).

To our knowledge, only one prior study has utilized TTM to examine disaster preparedness behavioral changes; using a multinomial logistic regression, Wirtz and Rohrbeck [22] estimated terrorism preparedness behavior changes for residents in Washington, D.C. from the precontemplation to contemplation stage and from the contemplation to action stage, respectively. They found perceived risk of a future terrorist attack had a greater influence on contemplating to prepare than on taking action to prepare. However, how behavior changes on an *ordinal* scale, such as that proposed in TTM, for promoting nationwide *natural hazard* preparedness has not been investigated.

2.3.1. Racial/ethnic disparities

Given TTM also postulates that factors influencing the transition from one stage to another are stage dependent, the prevalence of the factors present in each developmental stage in relation to socio-demographic profiles can be varied. In select states [23], Blacks and Hispanic Whites had much lower prevalence rates in achieving the "already prepared" developmental stage than their counterparts – non-Hispanic Whites. However, whether racial/ethnic disparities persistently prevail in the "intention to prepare" stage has not been reported, especially nationwide. Although racial/ethnic minorities had greater desire (intention) to achieve protective health behaviors (e.g., quitting smoking) than their counterparts, they were less likely to be successful doing so [24,25]. Nevertheless, whether racial/ethnic minorities are more or less likely than their counterparts to change their behaviors from one stage to another along the dynamic process of disaster preparedness has not been examined.

2.4. Social Cognitive Theory

Although it is one of the most cited models in the disaster preparedness literature, according to Samah [26], TTM itself does not incorporate social, economic, and environmental factors that can influence behavior changes. In parallel, many disaster researchers [18,27,28] adopted Social Cognitive Theory (SCT) [6] and Social Cognitive Model (SCM) [18] to explore human decision-making processes around disaster preparedness in relation to socioeconomic and environmental factors.

Derived from social learning theory [29], Bandura's [6] SCT explains how people regulate their behaviors through social and observational learning that occurs in a social context with a dynamic interaction of personal behavioral capabilities and their environment. First, SCT accentuates behavioral capability (or the actual ability of knowledge and skills, as well as access to resources) shaping one's behavior. Second, SCT addresses how learning that occurs within a social context, such as observational learning, might influence people's behavior. Finally, SCT emphasizes that self-efficacy, which refers to an individual's belief in their capacity to successfully take action, plays an important role in achieving goal-directed behavior [30].

2.4.1. Behavioral capability

Personal behavioral capability refers to the actual ability of a person to perform a behavior given their essential knowledge, skills, and access to resources [31,32]. Indicated as an individual's potential essential knowledge on disasters and the ability to mobilize resources for preparedness, educational attainment and income determine decision making with respect to disaster preparedness. For example, in Phang Nga province, Thailand, Muttarak & Pothisiri (2013) found educational attainment significantly facilitated behavior change in terms of disaster preparedness for Indian Ocean Tsunami survivors. Additional evidence from Puerto Rico and the Houston-Galveston metropolitan area in the U.S. suggests that low-income households were not able to afford homeowners' insurance [33] nor flood insurance [34,35], both of which are key to mitigating loss due to hurricanes [36]. Relatedly, education and income inequality in the U.S. is well-documented. Since 1959, the first year of the official times series statistics for the U.S. population, Hispanics and non-Hispanic Blacks have consistently had much lower levels of education attainment and household income than non-Hispanic Whites [37]. However, the extent to which socioeconomic status (SES) contributes to racial/ethnic disparities in behavior change from one stage of disaster preparedness to another has yet not been studied.

2.4.2. Experiences

SCT also takes into account a person's past experiences, which factor into whether behavioral action will occur [32]. Tekeli-Yeşil [38] reported that direct personal experience of an earthquake through participating in rescue(s) or solidarity activities positively influenced individuals to take precautionary actions to prepare for an expected earthquake in Istanbul. In the U.S., communities that experienced more flood events tended to have higher flood insurance penetration rates [39]. At the individual level, Nguyen et al. [40] found that, among Northridge earthquake survivors in Los Angles, their proximity to the epicenter and the level intensity of quake-shaking they experienced, are associated with increased post-quake preparedness and mitigation behavior. Building on this, it is important to note that many Americans have experienced more than one disaster event [41]. Cumulative disaster exposure was found to be a risk factor for exacerbating mental health conditions [42] and addictive behaviors [43]. However, whether cumulative disaster exposure acts as a barrier or as a facilitator in terms of one's behavior change for disaster preparedness, is not yet clear.

2.4.3. Awareness

According to SCT, through observational learning people can witness and observe a behavior conducted by others and then reproduce those actions. In the realm of disaster preparedness, the outcomes of observational learnings are reflected in one's awareness of the relevant knowledge. Karanci [44] found in Cankiri, Turkey, people who participated in a basic awareness training program on earthquake, landslide, and flood preparation, were more likely to adopt preparedness plans for disasters than their counterparts who did not participate. In the U.S., households with any prior awareness of preparedness information were more likely to develop and discuss an emergency plan than their counterpart households who had never been introduced to the concept [45]. In fact, people are regularly exposed to many different social learning environments, which allows their acquisition of preparedness knowledge to be varied in a cumulative way. For example, among our study group, many people have read, seen, or heard that preparedness actions are not limited to individual items (e.g., signing up for alerts and warnings, making an evacuation plan), but also include collaborative items (e.g., testing family communication plans and discussing plans with neighbors) [12,46]. Yet, the extent to which one's cumulative awareness of the relevant preparedness actions can influence the disaster preparedness decision-making process has not yet been investigated.

2.4.4. Self-efficacy

It is well documented that self-efficacy contributes to both preparedness intention and action. Affirmed by Gebrehiwot & van der Veen [47], self-efficacy led to a behavioral intention to undertake farm-level risk reduction measures in drought areas in the northern highlands of Ethiopia. In the U.S., people with higher levels of self-efficacy were more likely to take action to develop a household emergency plan [45]. Nevertheless, the intention-preparedness link could be disrupted if people lack resources for implementation. In a conceptualized SCM, Paton [18] posited while preparedness intention is a function of self-efficacy, some variables associated with an individual's actual capabilities (such as financial resources and income) have the potential to moderate the conversion of intentions to actions of preparedness. In fact, people with lower levels of resources are more likely to exhibit lower levels of self-efficacy to prepare for disasters [45]. If increasing income levels leads to an increased likelihood of taking an action for preparedness, it is possible that, at a certain level, increased incomes would also ameliorate the negative impact lower levels of self-efficacy have on behavior changes towards disaster preparedness.

2.5. Protection Motivation Theory and risk perception

First developed by Rogers [7], Protection Motivation Theory (PMT) was applied to understand how individuals are motivated to adopt self-protective behavior(s) in response to a perceived health threat. Emerged as a key theory of health psychology, PMT posits that one's intention to respond to information about potential hazards is a product of two distinct appraisal processes: the threat-appraisal process and the coping-appraisal process [48]. First, the threat-appraisal process consists of one's perceived severity of a threat and his/her perceived vulnerability (likelihood) of that threat happening. Second, the coping-appraisal process involves one's perceived response efficacy and self-efficacy, and then subtracting the response cost associated with adopting the action of behavioral change. PMT was later introduced in disaster literature as a rational and individual decision to prepare given a certain level of perceived threat (also known as risk perception) and based on the belief that the benefits of a protective behavior outweigh the associated costs [49,50].

The Protective Action Decision Model (PADM), developed by Lindell and Perry [51,52], postulates that people can obtain warning information from external sources about natural hazards or disasters. They believe such warning information contributes to the formation of individual risk perceptions which could lead to the protective behavior intentions and/or actual adoption of hazard adjustments. Although Lindell et al [53] also pointed out that "behavioral expectations are not necessarily the same as actual behavior," the roles of individual risk perceptions played on the dynamic process of behavior changes towards disaster preparedness (i.e., NP, IP and AP) has not been explored.

Further, Bourque et al [54] argue that risk perception itself is *not* a sufficient predictor but can be largely mediated or *moderated* by other factors, including socioeconomic variables. A more recent study reveals that, among Chinese farmers household, income positively moderates the relationship between soil pollution risk perception and environmental protection intention [55]. Nevertheless, whether household income levels moderate the effect of risk perception on the transition of individual behavior from one disaster preparedness stage to another has not yet been examined.

3. Theoretical model and research questions

Informed by TTM, we conceptualize individual disaster preparedness as a dynamic process of behavior changes along the ascending order from NP to IP to AP stages. Given existing literature suggests individuals do not necessarily act in accordance with their behavioral intentions [13], our theoretical model, likewise, does not assert that individual behavior change is necessarily taking a deterministic path along all three stages. Rather, we posit that people who have developed their intentions for preparedness since their departure from the NP stage may or may not arrive at AP stage. Relatedly, reaching the AP stage may be related to but not path-dependent on their successes in achievement of IP stage.

We also postulated the key elements of SCT and PMT (i.e., an individual's actual behavioral capability, SES, disaster experience, preparedness awareness, self-efficacy, and risk perception) each play a role in this dynamic decision-making process. As previous studies found, some variables may or may not have the same effects in shaping behavioral intentions and in realization of actual behaviors [13,18]. Accordingly, we relax a restrictive assumption that these key elements must have the same impact on facilitating an individual's departure from the NP stage and their arrival at the AP stage. More specifically, we postulate that SES, disaster experiences, preparedness awareness, self-efficacy, and risk perception may each have different effects on the dynamic process of behavior change towards disaster preparedness.

The main theoretical contributions of the present study are twofold. First, the study applies the TTM to understand behavior changes towards disaster preparedness as a dynamic decision-making process, with the caveat that racial/ethnic disparities impact who is able to achieve disaster preparedness. Building on this, the second part of this process-oriented approach integrates TTM with SCT and PMT to examine the roles of SES, disaster experience, preparedness awareness, and risk perception on behavior changes towards disaster preparedness and to evaluate the moderating roles of income on this process. Given this, we anticipate the possible policy implications as to how public assistance (e.g., increasing income levels through a cash transfer program) can effectively address the disaster preparedness needs of vulnerable groups—specifically, the subset who has developed an intent to prepare yet lacks the resources to achieve preparedness.

Focusing on the U.S. adult population, this study will address the following three questions:

1. Are there racial/ethnic disparities in the dynamic process of behavior changes towards disaster preparedness?
2. If so, to what extent does SES contribute to racial/ethnic disparities in the dynamic process of behavior changes towards disaster preparedness?
3. To what extent does personal disaster experience, preparedness awareness, self-efficacy, and risk perception each contribute to the dynamic process of behavior changes towards disaster preparedness, especially for people at different income levels?

4. Methods

To answer these questions, we employed a cross-sectional study design to analyze National Household Survey (NHS) data [46] containing individual behavior for disaster preparedness (N = 6,180). Representing the U.S. adult population in 2021, the NHS data also includes information on respondents' demographic and socioeconomic characteristics, past disaster experience, awareness of preparedness for future disasters, self-efficacy related to disaster preparedness, and disaster risk perceptions (as discussed in the introduction section).

4.1. Measurement

4.1.1. Outcome variable

NHS respondents were asked to choose one of the following five items to describe their disaster preparedness behaviors: 1. "I am not prepared, and I do not intend to prepare in the next year; " 2. "I am not prepared, but I intend to start preparing in the next year; " 3. "I am not prepared but I intend to get prepared in the next six months; " 4. "I have been prepared for the last year; " 5. "I have been prepared for more than a year and I continue preparing." Given this study aims to analyze whether and how preparedness behavior changes along different developmental stages, we acknowledge that such changes might be related to a series of hypothetical factors. Rather than predicting when such changes will occur, we simplified these categorical responses into three ordinal levels. Specifically, an individual's behavior is defined as "not prepared" (NP stage) if his/her response is 1 above; "having an intention to prepare though not prepared yet" (IP stage) if the response is 2 or 3 above, or "already prepared" (AP stage) if the response is 4 or 5 above.

4.1.2. Covariates

The covariates analyzed in this study can be clustered into three blocks according to their generic attributes. They are i). demographic characteristics; ii). socioeconomic status (SES); and iii). disaster experience, awareness for preparedness, self-efficacy, and risk perception.

Demographic Characteristics. The NHS contains demographic information from individual respondents, including racial and ethnic profiles, age, disability information, and whether they currently live with someone with special needs. Their operational definitions are as follows.

***Race/Ethnicity*.** The respondents were asked to self-identify their race and whether they were of Hispanic origin. We categorized these responses into a nominal variable, namely race/ethnicity, representing four mutually exclusive categories: White non-Hispanic (hereinafter referred to as Whites), Black non-Hispanic (hereinafter referred to as Blacks); Asian non-Hispanic (hereinafter referred to as Asians), and Hispanic (hereinafter referred to as Hispanics).

Older Adult. Consistent with the definition of older adults in existing disaster literature [56,57], a respondent with self-reported age of 60+ is defined as an "older adult" in this study; otherwise, not an older adult. This dichotomous variable is coded with values "1 = yes" and "0 = no."

***Disability*.** The respondents were asked to choose (yes or no) in response to the question, "Do you have a disability, or a health condition that might affect your capacity to respond to an emergency situation (a mobility, hearing, vision, cognitive, or intellectual disability or physical, mental, or health condition)." Accordingly, we operationally defined this dichotomous variable, with values "1 = yes" and "0 = no".

Living with someone with special needs. Similarly, we define the dichotomous variable, living with someone with special needs, with the coded values of "1 = yes" and "0 = no," according to how respondents answer the question of whether they are currently "living with or have primary responsibility for assisting elderly person or someone with a disability who requires assistance".

SES. The present study investigates the influence of socioeconomic status (SES) on personal behavior changes that occur in different developmental stages of disaster preparedness, as well as the impact of SES on possible racial/ethnic disparities in these changes. Consistent with the operational definition of SES in existing literature [58,59], our study focuses on two indicators - educational attainment and income.

Income. As shown in Table 1, the NHS released household income as a cardinal variable from "less than $10,000" to "$150,000 or more." We used it as a categorical variable for the purpose of reporting the prevalence of different preparedness behaviors across different income levels (for further detail, see the Statistical Analyses and Table 1). To predict the outcome variable in relation to the incremental change along household income levels, we used it as a numerical variable in all regression analyses.

Educational Attainment. The respondents self-reported their educational attainment, which, as presented in Table 1, varied from the lowest level of "less than a high school diploma" to the highest level of "post-graduation degree." Similarly, we employed educational attainment as a categorical variable to estimate the national rates of preparedness behaviors in different developmental stages across these educational attainment levels (Table 1); and adopted it as a numerical variable to model behavior transitions given the incremental change in educational attainment in all regression analyses (Table 2, 3, and 3).

Disaster Experience, Preparedness Awareness, Self-Efficacy, and Risk Perception. The NHS also includes a series of questions designed to capture respondents' personal experience with disasters, their awareness for preparedness actions, their perceived self-efficacy, and their risk perceptions. Using these responses, we then operationally defined each of the relevant variables as detailed below.

***Disaster Experience*.** The respondents were asked whether they have ever experienced a disaster, and were asked to respond with yes or no. In order to report the prevalence of preparedness behaviors contingent upon one's experience of any type of disaster event, we define it as a dichotomous variable, namely any disaster experience, with values "1 = yes" and "0 = no."

The respondents who indicated they had experienced a disaster were further asked to specify what type(s) of disaster they had experienced. The NHS provided these respondents with a list of 31 specific disaster types (e.g., flooding, drought, earthquake, extreme heat, hurricane, tornado, tsunamic, wildfire, etc.) and marked each with the values "1 = yes" and "0 = no." We added all the "yes" answers together to further define a numerical variable, namely cumulative disaster experience, or the total number of disaster events a respondent has experienced. The greater the number, the more disaster events a respondent has experienced.

***Preparedness Awareness*.** NHS respondents were also asked whether they have "read, seen, or heard about how to get better prepared for a disaster" for 12 specific items of preparedness action, with mutually exclusive answers to each itemized question

Table 1
Two-way analyses of disaster preparedness stages in relation to demographic characteristics, SES, disaster experience, preparedness awareness, risk perception, and self-efficacy.

	Disaster Preparedness Stages						Total	
	Not Prepared (NP stage)		Intend to Prepare (IP stage)		Already Prepared (AP stage)			
	%	95 % CI[a]	%	95 % CI	%	95 % CI	%	Obs[b]
Race/Ethnicity								
White, non-Hispanic	15	[13–17]	39	[37–42]	46	[44–49]	100	4,232
Black, non-Hispanic	11	[08–16]	46	[40–52]	43	[37–49]	100	642
Asian, non-Hispanic	11	[7–18]	50	[41–58]	39	[31–48]	100	316
Other, non-Hispanic	13	[7–23]	47	[36–57]	41	[31–51]	100	262
Hispanic	11	[09–15]	49	[44–53]	40	[36–44]	100	1,358
Total	14	[12–15]	42	[40–44]	44	[42–46]	100	6,810
Design-based F (7.92 53936.53) = 2.4608 Pr = 0.012								
Older adult								
No	13	[11–15]	44	[42–46]	43	[41–45]	100	4,974
Yes	15	[13–18]	38	[34–42]	47	[43–51]	100	1,836
Total	14	[12–15]	42	[40–44]	44	[42–46]	100	6,810
Design-based F (2.00 135,997) = 3.5752 Pr = 0.028								
Disability								
No	13	[12–15]	42	[40–44]	45	[42–47]	100	4,876
Yes	16	[13–20]	42	[37–47]	42	[38–47]	100	1,934
Total	14	[12–15]	42	[40–44]	44	[42–46]	100	6,810
Design-based F (1.99 13559.45) = 1.2874 Pr = 0.276								
Living with someone with special needs								
No	14	[13–16]	43	[41–46]	42	[40–44]	100	5,115
Yes	10	[07–13]	37	[32–42]	53	[49–58]	100	1,563
Total	13	[12–15]	42	[40–44]	44	[42–46]	100	6,678
Design-based F (2.00 13341.74) = 9.4601 Pr < 0.001								
Educational attainment (Education)								
Less than high school diploma	24	[18–31]	46	[39–54]	30	[24–38]	100	184
High school degree or diploma	13	[11–16]	47	[43–51]	40	[37–44]	100	1,268
Some college, no degree	12	[10–15]	43	[39–47]	45	[41–49]	100	1,444
Associate's degree	16	[12–21]	40	[34–46]	44	[39–50]	100	788
Bachelor's degree	12	[9–15]	41	[37–45]	47	[43–51]	100	1,601
Post graduate degree	8	[6–11]	31	[27–35]	61	[57–66]	100	1,525
Total	14	[12–15]	42	[40–44]	44	[42–46]	100	6,810
Design-based F (8.91 60659.88) = 8.0092 Pr < 0.001								
Household income (Income)								
Less than $10,000	19	[13–27]	47	[39–56]	33	[26–41]	100	468
$10,000 to $19,999	18	[13–24]	51	[45–58]	31	[25–37]	100	580
$20,000 to $29,999	15	[11–20]	46	[39–52]	39	[34–46]	100	723
$30,000 to $39,999	11	[8–16]	48	[42–55]	41	[35–47]	100	602
$40,000 to $49,999	11	[08–15]	42	[35–48]	48	[41–54]	100	573
$50,000 to $59,999	14	[10–19]	48	[42–55]	38	[32–44]	100	606
$60,000 to $99,999	12	[10–16]	43	[39–47]	45	[41–49]	100	1,489
$100,000 to $149,999	13	[10–17]	35	[30–40]	52	[47–57]	100	1,028
$150,000 or more	12	[9–17]	34	[29–39]	54	[48–59]	100	741
Total	14	[12–15]	42	[40–44]	44	[42–46]	100	6,810
Design-based F (15.67 106711.83) = 3.6973 Pr < 0.001								
Experienced with any disaster event (Any experience)								
No	20	[17–22]	45	[42–48]	35	[33–38]	100	2,669
Yes	8	[6–8]	40	[37–43]	53	[50–55]	100	3,932
Total	13	[12–14]	42	[40–44]	45	[43–47]	100	6,601
Design-based F (2.00 131,706) = 53.7319 Pr < 0.001								
At least one item for disaster preparedness (Any awareness)								
Not Aware at all	54	[47–61]	35	[28–42]	11	[07–16]	100	416
Aware of at least one item	10	[9–11]	43	[41–45]	48	[46–50]	100	6,272
Total	13	[12–14]	42	[40–44]	45	[43–47]	100	6,688
Design-based F (1.98 13238.29) = 161.0724 Pr < 0.001								
Self-Efficacy								
Low	28	[24–33]	51	[46–56]	20	[17–25]	100	1,023

(*continued on next page*)

Table 1 (*continued*)

	Disaster Preparedness Stages						Total	
	Not Prepared (NP stage)		Intend to Prepare (IP stage)		Already Prepared (AP stage)			
	%	95 % CI[a]	%	95 % CI	%	95 % CI	%	Obs[b]
Moderate	11	[9–13]	48	[45–50]	41	[39–44]	100	3,961
High	8	[6–10]	23	[38–43]	69	[65–73]	100	1,744
Total	13	[11–14]	42	[40–44]	45	[43–47]	100	6,728
Design-based F (3.9926815.80) = 70.5914 Pr < 0.000								
Risk perception								
Low	25	[21–29]	38	[34–42]	37	[33–41]	100	1,263
Moderate	9	[8–11]	48	[45–51]	43	[40–46]	100	3,093
High	9	[7–12]	35	[31–38]	56	[52–60]	100	2,145
Total	13	[12–14]	42	[40–44]	45	[43–47]	100	6,501
Design-based F (3.99 25926.63) = 31.7148 Pr < 0.001								
Total number of disaster events experienced (Cumulative disaster experience)								
	1.19	[0.86–1.37]	1.98	[1.82–2.14]	2.76	[2.57–2.95]		
Total	2.15 [2.04–2.27]							6,601
	Reference group[c]		0.86***		1.64***			
Total items of disaster preparedness (Preparedness awareness)								
	2.42	[2.09–2.76]	4.70	[4.51–4.89]	5.65	[5.47–5.83]		
Total	4.72 [4.59–4.84]							6,688
	Reference group[d]		2.28***		3.22**			

[a] 95 % Confidence Interval in brackets.
[b] Observations.
[c] "Not prepared" is used as a reference group in the weighted linear regression, with an outcome variable of "Experience".
[d] "Not prepared" is used as a reference group in the weighted linear regression, with an outcome variable of "Awareness".

(either "yes = 1" or "no = 0"). This included preparedness action items such as "Sign up for Alerts and Warnings," "Make a Plan," and "Know Evacuation Routes."

To construct a numerical variable, namely preparedness awareness, we summed all "yes" items for each respondent, as an awareness score (AS). The higher a respondent's AS, the higher the level of preparedness awareness this respondent possesses. To estimate the contingency distribution of preparedness behaviors on any preparedness item a respondent is aware of, we also define a dichotomous variable, namely any awareness, with values of "1 = yes" if a respondent's AS ≥ 1, or "0 = no" if the AS = 0.

Self-efficacy. Respondents were asked "how confident are you that you can take steps to prepare for a disaster in your area," and were given the following answers to choose from: "not at all confident," "slightly confident," "somewhat confident," "moderately confident," or "extremely confident." To determine perceived self-efficacy at three ordinal levels, we coded this as "low-level" for "not at all or slightly confident" responses, "moderate-level" for "somewhat or moderately confident" responses, and "high-level" for "extremely confident" responses.

Risk Perception. Finally, respondents were asked, "thinking about the area you live in, how likely would it be for a disaster to impact you?" They were provided the mutually exclusive choices of "unlikely," "likely," or "very likely." For the convenience of data interpretation, we coded risk perception at a "low-level" (or "low-risk") for an "unlikely" response; a "moderate-level" (or "moderate-risk") for a "likely" response; and a "high-level" (or "high-risk") for a "very likely" response.

4.2. Statistical analyses

We first estimated the weighted prevalence of disaster preparedness behaviors at different developmental stages upon each categorical covariate, with design-based F statistics reported in Table 1. We also reported the weighted means of all numerical variables for each preparedness stage and compared their mean differences using the weighted linear regressions, as shown in Table 1. As presented in Table 2, we further employed the weighted generalized ordered logistic regression to estimate unadjusted odds ratios for the behavior change from NP to either the IP or AP stage, and those ratios for the behavior change from NP or IP to AP stage, given each covariate. We employed the generalized ordered logistic regression to model behavior changes in these developmental stages, not just because the outcome variable itself is in ordinal scale, but also because it allows us to relax the proportional odds assumption for using a conventional ordered logistic regression model, which is both more parsimonious and more interpretable than those fitted by a multinomial logistic regression model [60].

Building on this, we employed a series of nested weighted generalized ordered logistic regression models to estimate the likelihood of behavior changing from NP to either IP or AP, and the likelihood of behavior changing from NP or IP to AP when the covariates were stepped into three models in a succeeding manner, as presented in Table 3. In Model 1 (Demographics), we report adjusted odds ratios for these behavior changes for racial/ethnic minorities while controlling for other demographic variables, the results of which provide direct evidence for answering the first research question. To examine the extent to which possible racial/ethnic disparities are accounted for by socioeconomic conditions (the second research question), we observed the adjusted odd ratios in these behavior changes for racial/ethnic minorities while further controlling for the covariates of educational attainment and income, as re-

Table 2
Estimating behavior changes for disaster preparedness by using simple generalized ordered logistic regressions (N = 6,145).

VARIABLES	Disaster Preparedness Stages	
	NP stage to IP or AP stage[a]	NP or IP stage to AP stage
	OR[b]	OR
Race/Ethnicity		
White, non-Hispanic^[c]		
Black, non-Hispanic	1.35	0.86
	[0.82–2.21][d]	[0.66–1.14]
Asian, non-Hispanic	2.47**[e]	0.79
	[1.20–5.09]	[0.53–1.19]
Other, non-Hispanic	0.96	0.79
	[0.44–2.11]	[0.49–1.26]
Hispanic	1.22	0.79**
	[0.84–1.78]	[0.63–0.98]
Constant	6.80***	0.94
	[5.81–7.96]	[0.84–1.04]
Older adult		
No^		
Yes	0.75*	1.11
	[0.57–1.00]	[0.92–1.34]
Constant	8.12***	0.84***
	[6.91–9.54]	[0.77–0.93]
Disability		
No^		
Yes	0.79	0.90
	[0.57–1.10]	[0.73–1.13]
Constant	7.74***	0.88***
	[6.68–8.97]	[0.81–0.96]
Living with someone with special needs		
No^		
Yes	1.43*	1.59***
	[0.98–2.07]	[1.28–1.97]
Constant	7.05***	0.80***
	[6.10–8.14]	[0.73–0.88]
Education		
	1.14***	1.18***
	[1.04–1.25]	[1.12–1.24]
Constant	4.90***	0.50***
	[3.47–6.91]	[0.40–0.62]
Income		
	1.05	1.12***
	[0.99–1.11]	[1.08–1.16]
Constant	5.69***	0.45***
	[4.00–8.10]	[0.36–0.57]
Cumulative disaster experience		
	1.19***	1.11***
	[1.11–1.28]	[1.07–1.14]
Constant	5.49***	0.69***
	[4.66–6.46]	[0.62–0.77]
Preparedness awareness		
	1.40***	1.16***
	[1.30–1.51]	[1.13–1.19]
Constant	2.09***	0.42***
	[1.65–2.65]	[0.36–0.49]
Self-Efficacy		
Low ^		
Moderate	2.99***	1.27**
	[2.20–4.08]	[1.03–1.58]
High	3.09***	2.16***
	[2.18–4.39]	[1.70–2.74]
Constant	3.46***	0.62***
	[2.79–4.28]	[0.52–0.74]

(*continued on next page*)

Table 2 (*continued*)

VARIABLES	Disaster Preparedness Stages	
	NP stage to IP or AP stage[a]	NP or IP stage to AP stage
	OR[b]	OR
Risk perception		
Low ^		
Moderate	3.48***	2.87***
	[2.56–4.74]	[2.16–3.81]
High	6.04***	9.20***
	[3.96–9.23]	[6.70–12.64]
Constant	2.53***	0.26***
	[1.97–3.25]	[0.20–0.34]

[a] NP: Not Prepared; IP: Intend to Prepare; Already Prepared.
[b] Odds ratio.
[c] Reference group.
[d] 95 % Confidence Interval.
[e] ***p < 0.01, **p < 0.05, *p < 0.1.

ported in Model 2. Then, to address the first part of research question three, we estimated the likelihood of these behavior changes given increased levels of disaster experience, preparedness awareness, self-efficacy, and risk perception (Model 3). To address the second part of research question three, we estimated the interaction effects of disaster experience (Model 4), preparedness awareness (Model 5), self-efficacy (Model 6), and risk perception (Model 7) on different income levels, with their results presented in Table 3. Given the significant interaction effect found in Model 7, we further calculated the predictive margins for study groups that had different levels of risk perception when they were at different income levels; then, plotted and contrasted their probabilities of NP, IP, and AP, as presented in Fig. 1.

Less than 10 % of the data used in this study exhibited missing data, including disability (1.94 %), disaster experience (3.07 %), preparedness awareness (1.79 %), self-efficacy (1.20 %), risk perception (4.54 %). To address this, we adopted the list-wise deletion (LWD) method in all logistic regression analyses (thus with the reduced N = 6,145), for its tolerance of both missing at random and missing not at random [61]. As an additional check, we also employed the multiple imputation (MI) method (M = 5) to estimate behavior changes in all multiple regressions. As shown in supplementary Table A and supplementary Table B, the results of these weighted generalized ordered logistic regressions with MI are consistent with those estimated by using the LWD method. All statistical analyses were carried out using the Stata MP 17 software package.

5. Results

Table 1 presents two-way analyses of disaster preparedness across three developmental stages (Not Prepared (NP), Intend to Prepare (IP), and Already Prepared (AP)) in relation to each covariate. We observed statistically significant disparities in these three stages by race/ethnicity, older adult status, living with someone with special needs, educational attainment, household income, disaster experience, preparedness awareness, and risk perception.

First, the progress of disaster preparedness is significantly different across different racial/ethnic groups at different developmental stages (p = 0.01). Whites have both the highest rates of NP (15 %, 95 % confidence interval (CI) [13 %, 17 %]) and AP (46 %, 95 CI [44 %, 49 %]). Asians have the highest prevalence of IP at 50 % (95 % CI [41 %, 58 %]) and the lowest prevalence of AP at 39 % (95 % CI [31 %, 48 %]). While Hispanics have the second highest prevalence rate of IP, (49 %, 95 % CI [44 %, 53 %]) and the second lowest prevalence of AP (40 %, 95 % CI [36 %, 44 %]), their weighted estimates are with much narrower confidence intervals than those parameters for Asians.

Older adults have a much higher prevalence rate of AP (47 %, 95 % CI [43 %, 51 %]) than their younger counterparts (43 %, 95 % CI [41 %, 45 %]). Although, across all developmental stages there is no significant difference between those with a disability and their counterparts without a disability, a statistically significant difference was observed in preparedness behaviors between those living with someone with special needs and their counterparts not living with anyone with special needs (p < 0.001). Specifically, people living with someone with special needs have substantially higher AP rate (53 %, 95 % CI [49 %, 58 %] than their counterparts (42 %, [95 % CI: 40 %, 44 %]), and a significant lower NP rate (10 %; 95 % CI [7 %, 13 %] than their counterparts (14 %, 95 % CI [13 %, 16 %]).

People with higher educational attainment tend to have higher AP prevalence rates. For example, among people with a post graduate degree the AP prevalence rate is 61 % (95 % CI [57 %, 66 %]), more than twice as high as the AP rate among their counterparts without a high school diploma (30 %, 95 % CI [24 %, 38 %]). Similarly, people with higher levels of household income tend to be better prepared for disasters. For example, the AP prevalence rate among those with household income at $150,000 or more (54 %, 95 % CI [48 %, 59 %]) is nearly twice as high as the AP rate achieved by their counterparts with the household income level between $10,000 and $19,999 (31 %; 95 % CI [25 %, 37 %]).

People who have experienced at least one disaster event not only have a much higher AP prevalence rate (53 %, 95 % CI [50 %, 55 %]) than their counterparts who did not have any experience of a disaster event (35 %, 95 % CI [33 %, 38 %]), but also have a

Table 3
Estimating behavior changes for disaster preparedness by using weighted multiple generalized ordered logistic regressions (N = 6,145).

VARIABLES	Model 1. Demographics		Model 2. SES		Model 3. Experience, Awareness, Risk Perception & Self-Efficacy	
	NP stage to IP or AP stage[a]	NP or IP stage to AP stage	NP stage to IP or AP stage	NP or IP stage to AP stage	NP stage to IP or AP stage	NP or IP stage to AP stage
	AOR[b]	AOR	AOR	AOR	AOR	AOR
Race/Ethnicity						
White, non-Hispanic ^[c]						
Black, non-Hispanic	1.28 [0.78–2.10][d]	0.87 [0.66–1.14]	1.41 [0.86–2.30]	0.99 [0.75–1.31]	1.58* [0.95–2.62]	0.96 [0.70–1.32]
Asian, non-Hispanic	2.40**[e] [1.16–4.96]	0.81 [0.53–1.23]	2.28** [1.10–4.75]	0.79 [0.51–1.22]	3.21*** [1.51–6.83]	1.03 [0.66–1.61]
Other, non-Hispanic	0.92 [0.41–2.03]	0.81 [0.50–1.30]	0.99 [0.46–2.17]	0.87 [0.54–1.41]	0.98 [0.41–2.35]	0.86 [0.50–1.47]
Hispanic	1.14 [0.77–1.68]	0.79** [0.63–0.99]	1.25 [0.85–1.84]	0.87 [0.69–1.10]	1.49** [1.02–2.19]	0.97 [0.76–1.24]
Older adult						
No ^						
Yes	0.81 [0.61–1.08]	1.10 [0.91–1.34]	0.80 [0.60–1.08]	1.13 [0.93–1.38]	0.94 [0.69–1.27]	1.27** [1.03–1.56]
Disability						
No ^						
Yes	0.75* [0.54–1.04]	0.77** [0.61–0.96]	0.82 [0.59–1.15]	0.88 [0.70–1.10]	0.70** [0.50–0.98]	0.83 [0.65–1.06]
Living with someone with special needs						
No^						
Yes	1.51** [1.06–2.15]	1.71*** [1.37–2.15]	1.49** [1.05–2.13]	1.72*** [1.37–2.15]	1.10 [0.74–1.64]	1.62*** [1.25–2.08]
Education			1.14** [1.02–1.27]	1.11*** [1.04–1.18]	1.10* [0.98–1.23]	1.08** [1.01–1.15]
Income			1.01 [0.94–1.08]	1.08*** [1.04–1.13]	0.97 [0.90–1.04]	1.07*** [1.03–1.12]
Cumulative disaster experience					1.08** [1.01–1.16]	1.05*** [1.01–1.08]
Preparedness awareness					1.34*** [1.24–1.44]	1.11*** [1.07–1.14]
Self-Efficacy						
Low ^						
Medium					2.82*** [2.03–3.93]	2.58*** [1.94–3.43]
High					4.08*** [2.67–6.21]	6.83*** [4.94–9.45]
Risk perception						
Low ^						
Moderate					2.76*** [1.98–3.83]	1.20 [0.94–1.51]
High					2.33*** [1.59–3.42]	1.56*** [1.20–2.05]
Constant	7.22*** [5.81–8.98]	0.86** [0.75–0.98]	4.43*** [2.79–7.04]	0.36*** [0.27–0.49]	0.37*** [0.21–0.66]	0.06*** [0.04–0.09]
Observations	6,145	6,145	6,145	6,145	6,145	6,145

[a] NP: Not Prepared; IP: Intend to Prepare; AP: Already Prepared.
[b] Reference group.
[c] Adjusted Odds ratio.
[d] 95 % confidence interval in bracket.
[e] ***p < 0.01, **p < 0.05, *p < 0.1.

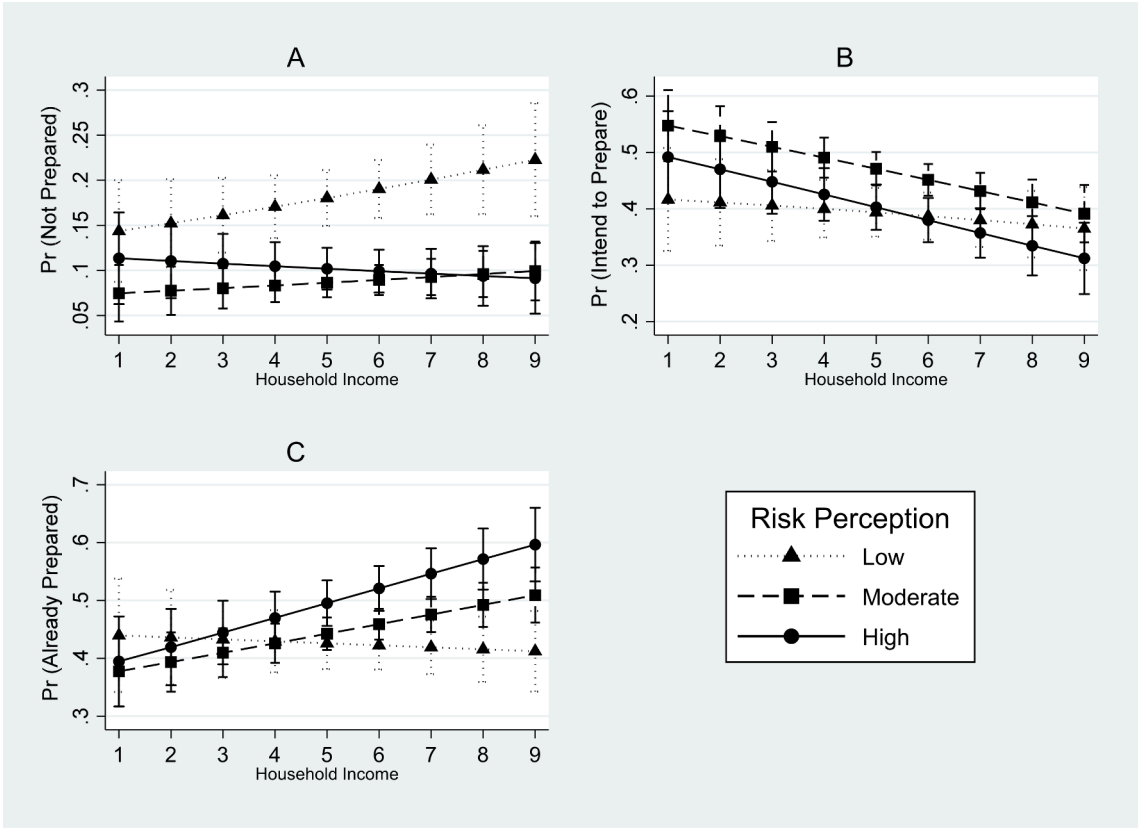

Fig. 1. Predictive margins of not prepared (NP), intend to prepare (IP), and already prepared (AP) with 95 % confidence intervals.
Note Pr = Probability. Whiskers indicate 95 % confidence intervals. Household Income: less than $10,000; $100,000 to $19,999; $20,000 to $29,999; $30,000 to $39,999; $40,000 to $49,999; $50,000 to $59,999; $60,000 to $99,999; $100,00 to $149,999; $150,000 or more.

much lower NP prevalence rate (8 %, 95 % CI [6 %, 8 %]) than their counterparts (20 %, [17 %, 22 %]). People with preparedness behaviors in the AP stage have the highest mean value for total number of disaster events they have experienced (M = 2.76; 95 % CI [2.57, 2.95], followed by those with preparedness behaviors in the IP stage (M = 1.98, 95 % CI [1.82, 2.14], and those in the NP stage (M = 1.19, 95 % CI [0.86, 1.37]). We then utilized a simple weighted linear regression and determined that the mean differences are statistically significant between those in the AP stage and those in the NP stage ($b = 1.64$, $p < 0.001$), as well as between those in the IP stage and those in the NP stage ($b = 0.86$, $p < 0.001$).

The prevalence of AP among respondents who have been aware of at least one item of disaster preparedness (48 %, 95 % CI [46 %, 50 %]) is more than four times higher than that of those who have *not* been aware of any item of preparedness (11 %, 95 % CI [7 %, 16 %]). People whose preparedness behaviors were in the AP stage have the highest mean in terms of total number of items of preparedness awareness (M = 5.65, 95 % CI [5.47, 5.83]), followed by those in the IP stage ((M = 4.70, 95 % CI [4.51, 4.89], and those in the NP stage (M = 2.42, 95 % CI [2.09, 2.76]). We again used a simple weighted linear regression and found the mean differences between them are statistically significant (AP vs. NP: $b = 3.22$, $p < 0.001$; IP vs. NP: $b = 2.28$, $p < 0.001$).

Finally, people with high-risk perceptions have the highest prevalence of AP (56 %, 95 % CI [52 %, 60 %]), and the lowest prevalence of NP (9 %, 95 % CI [7 %, 12 %]). In contrast, people with low-risk perceptions have the lowest prevalence of AP (37 %, 95 % CI [33 %, 41 %]) and the highest rate of NP (25 %, 95 % CI [21 %, 29 %]). It is also noted that people with moderate-risk perceptions have the highest prevalence rate of IP (48 %, 95 % CI [45 %, 51 %]).

Table 2 reports unadjusted odds ratios (OR) of a). the behavior change from the NP stage to the IP or AP stage (departing from the NP stage to either the IP or AP stage); and b). the behavior change to the AP stage from either the IP or NP stage (in other words, arriving at the AP stage regardless of departing from the IP or NP stage), respectively. The odds of achieving AP for Hispanics are more than 21 % lower than that for their white counterparts, at a statistically significant level (OR = 0.79, 95 % CI [0.63, 0.98]). Asians are less likely than their white counterparts to advance to the AP stage (OR = 0.79, 95 % CI [0.53, 1.19]), although they are more likely than their counterparts to depart from NP stage (OR = 2.47, 95 % CI [1.20, 5.09]).

Educational attainment significantly contributes to both behavior changes in departure from the NP stage (OR = 1.14, 95 % CI [1.04, 1.25]) and in arrival at the AP stage (1.18, 95 % CI [1.12, 1.24]). Individuals with higher income levels are more likely to advance to the AP stage at a highly statistically significant level (OR = 1.12, 95 % CI [1.08, 1.16]). As detailed in Table 2, cumulative disaster experience, preparedness awareness, self-efficacy, and risk perception *each* significantly facilitates preparedness behavior changes in departure from the NP stage and in arrival at the AP stage.

Table 3 presents adjusted odds ratios (AOR) for all covariates that were stepped into three generalized ordered logistic regression models in a succeeding manner. Model 1 shows that, while controlling for other demographic variables, Hispanics are still significantly less likely than Whites to advance to the AP stage (AOR = 0.79, 95 % CI [0.63, 0.99]). In contrast to people without a disability, people with a disability are less likely to make it to the AP stage (AOR = 0.77, 95 % CI [0.61, 0.96]) when controlling for other demographic characteristics. Compared with those who aren't residing with someone with special needs, people living with someone with special needs are not just significantly more likely to depart from the NP stage (AOR = 1.51, 95 % CI [1.06, 2.15]), they are also more likely to arrive at the AP stage (AOR = 1.71, 95 % CI [1.37, 2.15]).

While controlling for all demographic variables, the results of Model 2 first suggest higher educational attainment still significantly contributes to both behavior changes in departure from the NP stage (AOR = 1.14, 95 % CI [1.02, 1.27]) and in arrival at the AP stage (AOR = 1.11, 95 % CI [1.04, 1.18]). Second, with increased income levels, people are more likely to advance to the AP stage at a highly statistically significant level (AOR = 1.08, 95 % CI [1.04, 1.13]); however, increasing income levels alone does *not* significantly influence behavior change to have such an intention to do so (AOR = 1.01, 95 % CI [0.94, 1.08]). Third, with the addition of SES indicators, neither Hispanics nor those with disability status had a significant odds ratio in any transitions across the developmental stages. This could, perhaps, be due to disparities in SES among study group members who are in different racial/ethnic groups and have different disability statuses. Assuming this, we ran two additional weighted linear regressions to estimate educational attainment and income levels, respectively, using all demographic variables as predictors. These results can be seen in the supplementary Table C and suggest that Hispanics and people with a disability indeed have lower SES than their counterparts, respectively ($p < 0.001$).

The results in Model 3 indicate that cumulative disaster experience, preparedness awareness, self-efficacy, and risk perception significantly contribute to advancing across developmental stages for disaster preparedness. People who experienced more disaster events (AOR = 1.08, 95 % CI [1.01, 1.16]) and people with higher levels of preparedness awareness (AOR = 1.34, 95 % CI [1.24, 1.44]) were relatively more likely to depart from the NP stage, and also relatively more likely to arrive at the AP stage (Disaster experience: AOR = 1.07, 95 % CI [1.01, 1.08]; Awareness: AOR = 1.11, 95 % CI [1.07, 1.14]). In contrast to people with low levels of self-efficacy, people with moderate and higher levels of self-efficacy were not just more likely to depart from the NP stage (Moderate level: AOR = 2.82, 95 % CI [2.03, 3.93]; High level: AOR = 4.08, 95 % CI [2.67, 6.21]), but were also more likely to arrive at the AP stage (Moderate level: AOR = 2.58, 95 % CI [1.94, 3.43]; High level: AOR = 6.83, 95 % CI [4.94, 9.45]). Compared to their counterparts with low-risk perceptions, both people with moderate-risk perceptions (AOR = 2.76, 95 % CI [1.98, 3.83]) and people with high-risk perceptions (AOR = 2.33, 95 % CI [1.59, 3.42]) are more likely to depart from the NP stage. Nevertheless, only those with high-risk perceptions are significantly more likely to arrive at the AP than their counterparts (OR = 1.56, 95 % CI [1.20, 2.05]).

Compared with the results in Model 2, the estimates of departing from the NP stage for Asians, Hispanics, and Blacks in Model 3 are much more significant (Asians: AOR = 3.21, 95 % CI [1.51, 6.83]; Hispanics: AOR = 1.49, 95 % CI [1.02, 2.19]; Blacks: AOR = 1.58, 95 % CI [0.95, 2.62]). Such observed phenomena may be due to these racial/ethnic minority groups experiencing *fewer* disaster events; having lower levels of preparedness awareness; and/or having higher-risk perceptions than their white counterparts. To test these assumptions, we employed two weighted multiple linear regressions to predict "Cumulative disaster experience (Total number of disaster events experienced)" and "Preparedness Awareness," respectively; then, using other covariates as predictors, we adopted two generalized ordered logistic regressions to estimate the increased likelihood associated with "Self-Efficacy" and "Risk Perception," respectively. As the statistical results reported in supplementary Table D show, Hispanics ($b = -0.59$, $p < 0.01$) and Asians ($b = -0.48$, $p = 0.06$) are more likely to experience fewer disaster events than their white counterparts. Blacks ($b = -0.54$, $p = 0.02$) and Hispanics ($b = -0.29$, $p = 0.08$) have much lower levels of preparedness awareness than Whites. Further, in contrast to their white counterparts, Blacks and Hispanics are more likely to have higher risk perception levels (detailed in Supplementary Table D).

Table 3 further presents the results of four interaction effects: income and disaster experience (Model 4); income and preparedness awareness (Model 5); income and self-efficacy (Model 6), and income and risk perception (Model 7). None of these are statistically significant, aside from high-risk perceptions and higher levels of income, which, together, jointly changes people's preparedness behavior to the AP stage (AOR = 1.14, 95 % CI [1.03, 1.27]).

Fig. 1 visually presents the predictive margins of NP (A), IP (B), and AP (C) for people with different levels of risk perceptions when their incomes are varied from the lowest level (<$10k) to the highest level (≥$150k). Fig. 1 (A) depicts that for people with increased income levels, the probabilities of NP for people with low-risk perceptions are *increased* while that for people with high-risk perceptions are *decreased*. For example, when income is increased to $150,000 or higher, the mean probability of NP for people with low-risk perceptions (Pr = 0.22, 95 % CI [0.16, 0.28]) is significantly higher than that for people with moderate-risk perceptions (Pr = 0.10, 95 % CI [0.07, 0.13]) or people with high-risk perceptions (Pr = 0.09, 95 % CI [0.05, 0.13]). Fig. 1 (B) indicates that for people with increased income levels, the probability of IP is decreased across all three risk perception groups (low, medium, and high), though this is not statistically significant at any income level. Fig. 1 (C) shows that along with increased income levels, the probability of AP increases dramatically for both the high- and moderate-risk perception groups, yet decreases for the low-risk perception group. When income is increased to $150,000 or higher, the mean probability of AP for people with high-risk perceptions (Pr = 0.60, 95 % CI [0.53, 0.66]) is significantly higher than for people with low-risk perceptions (Pr = 0.41, 95 % CI [0.34, 0.48]).

6. Conclusion and discussion

Through integrating TTM with SCT and PMT and employing generalized ordered logistic regressions to examine and measure individual behavioral transitions, this population study identified a series of risk and protective factors associated with the dynamic process of human behavior changes towards disaster preparedness. Turning to the first research question, results suggest that, on a nationwide scale, although Hispanics are more likely than their non-Hispanic white counterparts to depart from the NP stage, they are less likely than their counterparts to take action to prepare for disasters. The latter part of this finding is consistent with the existing literature on ethnic disparities in disaster preparedness as identified in five selected states [23]. Moving to the second research question, our findings demonstrate that ethnic disparities in disaster preparedness are largely due to socioeconomic inequalities (i.e., educational attainment and income). Importantly, household income plays *different* roles in the disaster preparedness decision-making process. With increased income levels, people were more likely to take action to prepare for disasters, though they did *not necessarily* have the intention to do so. When the effects of disaster experience(s), preparedness awareness, self-efficacy, and risk perception are isolated, as presented in statistical Model 3, increasing income levels will decrease the likelihood of behavior change in departure from the NP stage, though not at a statistically significant level.

Turning to the first part of the third research question, we found that people who experienced more disaster events developed higher levels of disaster preparedness awareness, and coupled with moderate or high levels of self-efficacy, they were not only more likely to have an intention to prepare, but also more likely to take action to do so. Finally, and most importantly, for individuals with high-risk perceptions, increased income results in taking action to prepare for future disaster(s). However, this moderated effect is not present in people with low and moderate risk perception levels.

Furthermore, our study first documented that among people not prepared for a disaster, those who live with and have the primary responsibility of taking care of someone with special needs, is more likely to contemplate preparing for disaster and then to convert this contemplation into action. Perhaps, primary caretakers' relatively advanced preparedness behaviors can be explained by findings from this study showing that i). they endure more disaster events ($b = 0.51$, $p < 0.01$); and/or, ii). they are more likely to perceive higher levels of risk than their counterparts (low to moderate or high levels: AOR = 1.82, 95 % CI [1.30, 2.54]; low or moderate to high levels: AOR = 1.50, 95 % CI [1.19, 1.89], detailed in supplementary Table D).

By integrating SCT and PMT, our study enriches the application of TTM in studying human behavior for disaster preparedness. Developing a parsimonious theoretical model with an ascending order for behavior changes allowed us to provide evidence that individual preparedness for all types of disaster scenarios is a dynamic process whereby an individual moves from "not prepared" (NP), to "intention to prepare" (IP), then to the "already prepared" (AP) stage. Human behavior changes towards disaster preparedness along these developmental stages can be sufficiently explained using both SCT and PMT. In detail, preparedness behaviors at the individual level can be regulated by an individual's behavioral capabilities, understanding of essential knowledge and skills, and access to resources (educational attainment and income). It can also be learned through prior experience (disaster experience) or acquired through observational learning (preparedness awareness), and can be facilitated by an individual's self-efficacy for disaster preparedness. Along this dynamic process, individuals with relatively higher levels of risk perception are more likely to begin to contemplate and to make decisions to protect their properties and themselves. Moreover, enhancing behavioral capability through expanding access to resources (i.e., increasing income) can boost the realization of taking action (or reaching the AP stage) among the individuals with high-level of risk perception.

Despite these important findings, our study is not without limitations. First, the major focus of this U.S. population study is to develop a theory-based model of human behavior change for protecting life and property in *all* hazardous situations. Hence, we did not evaluate personal preparedness behavior for any *specific* hazards, which could be performed differently among different subpopulations with different emergent conditions. For example, older adults using electrically powered medical devices might be more sensitive to the hazard of a power outage [62]. Future studies should further investigate the extent to which preparedness behavioral changes among older adults for this particular emergent crisis are associated with the risk and protective factors identified in our study. Second, although we identify a series of risk and protective factors associated with preparedness behaviors along the developmental stages, pathways associated with behavioral changes should be further examined. For example, it is possible that personal disaster experience triggers preparedness awareness, which, in turn, could direct behavior changes towards preparedness. It is also reasonable to speculate that personal disaster experience leads to high-levels of risk perception, which ultimately contributes to behavioral changes once income is sufficient. Future studies should test these hypotheses by using path analysis, especially when panel data is available. Finally, the 2021 National Household Survey listed 12 preparedness actions and asked the respondents whether they had taken action on each of them. These actions, for example, are "make your home safer," "save for a rainy date," and "test family communication plan." A recent report by FEMA [12] reveals that correspondingly, 45 % of respondents made their home safer; 44 % saved for a rainy day; and 25 % tested family communication plan. Future studies should adopt the present process-oriented approach to further examine the dynamic behavior changes towards each of these specific preparedness items.

Nevertheless, this is the first national study to investigate individual behavior changes towards disaster preparedness in ascending stages in relation to social vulnerability, disaster experience, preparedness awareness, self-efficacy, and risk perception level. Given study findings, we propose a series of comprehensive policy interventions.

First, increasing the actual capabilities of socially vulnerable groups to prepare for disaster by instituting *income redistribution* is exigent. Cash-transfer projects such as Mayors for Guaranteed Income [63] have been tested as an effective intervention to change health and behavior outcomes among socially vulnerable groups. Mayors in disaster-prone communities might consider adding the aim of disaster preparedness to future cash-transfer projects. Second, to enhance awareness of disaster preparedness, social/observational learning opportunities for community members should be provided in both quantity and quality. For example, to build "a cul-

ture of preparedness" among citizens, FEMA launched the Community Emergency Response Team (CERT) program in all states to educate volunteers about disaster preparedness for hazards that may uniquely occur where they live. Although there are 2,700 unique CERT programs at the community level and more than 600,000 people have been trained [64], capacity across participating communities is not equal. For example, Flint and Stevenson [65] reported that urban or suburban Illinois CERT programs often have a larger infrastructure and more resources, while rural CERT program coordinators more readily acknowledge that resources may not be able to cover all community members, even following a major disaster. Finally, to maximize the effectiveness of a possible policy intervention (e.g., the MGI cash-transfer projects as discussed above), people with high risk perception levels should be prioritized to receive financial resources to support their preparedness activities.

CRediT authorship contribution statement

Chenyi Ma: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization, Funding acquisition, Project administration, Resources. **Dennis P. Culhane:** Writing – review & editing, Supervision. **Sara S. Bachman:** Writing – review & editing, Supervision.

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

Given the de-identified dataset used in this study is publicly accessible, it is our understanding that no documentation of an ethics approval (EA) procedure is required for using such data.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijdrr.2024.104606.

References

[1] Centre for Research on the Epidemiology of Disasters (CRED), EM-DAT - the international disaster database, https://www.emdat.be/, 2024.
[2] D. Tin, L. Cheng, D. Le, R. Hata, G. Ciottone, Natural disasters: a comprehensive study using EMDAT database 1995–2022, Publ. Health 226 (2024) 255–260, https://doi.org/10.1016/j.puhe.2023.11.017.
[3] D.E. Alexander, Principles of Emergency Planning and Management, Oxford University Press, 2002.
[4] D.E. Alexander, Disaster and emergency planning for preparedness, response, and recovery, in: Oxford Research Encyclopedia of Natural Hazard Science. (Pp. 1-20), Oxford University Press, Oxford, 2015 https://doi.org/10.1093/acrefore/9780199389407.013.12 (2015) (Vol. 1, pp. 1–20). Oxford University Press.
[5] International Federation of Red Cross and Crescent Societies, Disaster Preparedness Training Programme: *Introduction to Disaster Preparedness*, 2000 Geneva, Switzerland: Available at: http://www.preventionweb.net/files/2743_Introdp.pdf.
[6] A. Bandura, Social Foundations of Thought and Action: A Social Cognitive Theory, Prentice-Hall, Inc., 1986.
[7] R.W. Rogers, A protection motivation theory of fear appeals and attitude change 1, J. Psychol. 91 (1) (1975) 93–114, https://doi.org/10.1080/00223980.1975.9915803.
[8] P. Bubeck, W.J.W. Botzen, H. Kreibich, J.C.J.H. Aerts, Detailed insights into the influence of flood-coping appraisals on mitigation behaviour, Global Environ. Change 23 (5) (2013) 1327–1338, https://doi.org/10.1016/j.gloenvcha.2013.05.009.
[9] L.T. Ejeta, A. Ardalan, D. Paton, Application of behavioral theories to disaster and emergency health preparedness: a systematic review, PLoS Currents Disasters 7 (2015), https://doi.org/10.1371/currents.dis.31a8995ced321301466db400f1357829.
[10] S. Rao, F.C. Doherty, S. Teixeira, Are you prepared? Efficacy, contextual vulnerability, and disaster readiness, Int. J. Disaster Risk Reduc. 77 (2022) 103072, https://doi.org/10.1016/j.ijdrr.2022.103072.
[11] M. Scovell, C. McShane, A. Swinbourne, Experience and the perceived efficacy of cyclone preparedness behaviour, International Journal of Disaster Resilience in the Built Environment 12 (2) (2021) 170–183, https://doi.org/10.1108/IJDRBE-04-2020-0031.
[12] Federal Emergency Management Agency, FEMA Data Digest: Low- and No-Cost Ways to Prepare, 2022 March 1. https://community.fema.gov/PreparednessConnect/s/article/FEMA-Data-Digest-Low-and-No-Cost-Ways-to-Prepare.
[13] V. Basolo, L.J. Steinberg, R.J. Burby, J. Levine, A.M. Cruz, C. Huang, The effects of confidence in government and information on perceived and actual preparedness for disasters, Environ. Behav. 41 (3) (2009) 338–364, https://doi.org/10.1177/0013916508317222.
[14] D. Kyne, L. Cisneros, J. Delacruz, B. Lopez, C. Madrid, R. Moran, A. Provencio, F. Ramos, M.F. Silva, Empirical evaluation of disaster preparedness for hurricanes in the Rio Grande Valley, Progress in Disaster Science 5 (2020) 100061, https://doi.org/10.1016/j.pdisas.2019.100061.
[15] G.D. Brown, A. Largey, C. McMullan, The influence of expertise on perceived and actual household disaster preparedness, Progress in Disaster Science 9 (2021) 100150, https://doi.org/10.1016/j.pdisas.2021.100150.
[16] L.J. Vinnell, T.L. Milfont, J. McClure, Why do people prepare for natural hazards? Developing and testing a Theory of Planned Behaviour approach, Current Research in Ecological and Social Psychology 2 (2021) 100011, https://doi.org/10.1016/j.cresp.2021.100011.
[17] J.-S. Tang, J.-Y. Feng, Residents' disaster preparedness after the Meinong Taiwan earthquake: a test of protection motivation theory, Int. J. Environ. Res. Publ.

Health 15 (7) (2018) 1434, https://doi.org/10.3390/ijerph15071434.
[18] D. Paton, Disaster preparedness: a social-cognitive perspective, Disaster Prev. Manag. 12 (3) (2003) 210–216, https://doi.org/10.1108/09653560310480686.
[19] C.C. DiClemente, S.O. Hughes, Stages of change profiles in outpatient alcoholism treatment, J. Subst. Abuse 2 (2) (1990) 217–235, https://doi.org/10.1016/S0899-3289(05)80057-4.
[20] J.O. Prochaska, C.C. DiClemente, Transtheoretical therapy: toward a more integrative model of change, Psychother. Theory Res. Pract. 19 (3) (1982) 276–288, https://doi.org/10.1037/h0088437.
[21] J.O. Prochaska, C.C. DiClemente, W.F. Velicer, J.S. Rossi, Criticisms and concerns of the transtheoretical model in light of recent research, Br. J. Addict. 87 (6) (1992) 825–828, https://doi.org/10.1111/j.1360-0443.1992.tb01973.x.
[22] P.W. Wirtz, C.A. Rohrbeck, The dynamic role of perceived threat and self-efficacy in motivating terrorism preparedness behaviors, Int. J. Disaster Risk Reduc. 27 (2018) 366–372, https://doi.org/10.1016/j.ijdrr.2017.10.023.
[23] E. Ablah, K. Konda, C.L. Kelley, Factors predicting individual emergency preparedness: a multi-state analysis of 2006 BRFSS data, Biosecur. Bioterrorism Biodefense Strategy, Pract. Sci. 7 (3) (2009) 317–330, https://doi.org/10.1089/bsp.2009.0022.
[24] S. Babb, A. Malarcher, G. Schauer, K. Asman, A. Jamal, Quitting smoking among adults—United States, 2000-2015, MMWR. Morbidity and Mortality Weekly Report 65 (52) (2017) 1457–1464, https://doi.org/10.15585/mmwr.mm6552a1.
[25] M. Santiago-Torres, D.M. Kwon, K.E. Mull, B.M. Sullivan, J.S. Ahluwalia, A.C. Alexander, N.L. Nollen, J.B. Bricker, Efficacy of web-delivered acceptance and commitment therapy (ACT) for helping Black adults quit smoking, Journal of Racial and Ethnic Health Disparities (2022), https://doi.org/10.1007/s40615-022-01458-5.
[26] A.A. Samah, Z. Zaremohzzabieh, H. Mohd Shaffril, J. Dsilva, J. Lawrence, S. Kamarudin, Researching natural disaster preparedness through health behavioral change models, American Journal of Disaster Medicine 14 (2019) 51–63, https://doi.org/10.5055/ajdm.2019.0315.
[27] R.M. Adams, H. Rivard, D.P. Eisenman, Who participates in building disaster resilient communities: A cluster-analytic approach, J. Public Health Manag. Practice 23 (1) (2017) 37, https://doi.org/10.1097/PHH.0000000000000387.
[28] D. McIvor, D. Paton, D. Johnston, Modelling community preparation for natural hazards: Understanding hazard cognitions, J. Pacific Rim Psychol. 3 (2) (2009) 39–46, https://doi.org/10.1375/prp.3.2.39.
[29] A. Bandura, Social Learning Theory, first ed., Prentice-Hall, 1976.
[30] A. Bandura, Self-efficacy: toward a unifying theory of behavioral change, Psychol. Rev. 84 (1977) 191–215, https://doi.org/10.1037/0033-295X.84.2.191.
[31] J.R. Bezner, E.C.H. Bradford, Integrating health promotion and wellness into neurorehabilitation, in: R. Lazaro, S. Reina-Guerra, M. Quiben (Eds.), Umphred's Neurological Rehabilitation, seventh ed., Mosby, 2020, pp. 938–952.
[32] W.W. LaMorte, *The Social Cognitive Theory* [Behavioral Change Models], Boston University School of Public Health, 2022 November 3). https://sphweb.bumc.bu.edu/otlt/mph-modules/sb/behavioralchangetheories/behavioralchangetheories5.html.
[33] C. Ma, A.C. Baker, T.E. Smith, How income inequality influenced personal decisions on disaster preparedness: a multilevel analysis of homeowners insurance among Hurricane Maria victims in Puerto Rico, Int. J. Disaster Risk Reduc. 53 (2021) 101953, https://doi.org/10.1016/j.ijdrr.2020.101953.
[34] C. Ma, Home Recovery in New Orleans after Hurricane Katrina [Ph.D, University of Pennsylvania, 2018 from. https://www.proquest.com/docview/2112370280/abstract/1F5AD8153D92408EPQ/1. (Accessed 17 April 2024).
[35] C. Ma, D.P. Culhane, Addressing low-income household sheltering needs after a disaster: a needs assessment among Hurricane Harvey housing victims, Hous. Stud. (2022) 1–16, https://doi.org/10.1080/02673037.2022.2149704.
[36] M. Montgomery, H. Kunreuther, Pricing storm surge risks in Florida: implications for determining flood insurance premiums and evaluating mitigation measures, Risk Anal. 38 (11) (2018) 2275–2299, https://doi.org/10.1111/risa.13127.
[37] J. Iceland, Racial and ethnic inequality in poverty and affluence, 1959–2015, Popul. Res. Pol. Rev. 38 (5) (2019) 615–654, https://doi.org/10.1007/s11113-019-09512-7.
[38] S. Tekeli-Yeşil, N. Dedeoğlu, C. Braun-Fahrlaender, M. Tanner, Factors motivating individuals to take precautionary action for an expected earthquake in Istanbul, Risk Anal. 30 (8) (2010) 1181–1195, https://doi.org/10.1111/j.1539-6924.2010.01424.x.
[39] E. Michel-Kerjan, S. Lemoyne de Forges, H. Kunreuther, Policy tenure under the U.S. National flood insurance program (NFIP), Risk Anal. 32 (4) (2012) 644–658, https://doi.org/10.1111/j.1539-6924.2011.01671.x.
[40] L.H. Nguyen, H. Shen, D. Ershoff, A.A. Afifi, L.B. Bourque, Exploring the causal relationship between exposure to the 1994 Northridge Earthquake and pre- and post-earthquake preparedness activities, Earthq. Spectra 22 (3) (2006) 569–587, https://doi.org/10.1193/1.2219108.
[41] W.F. Benson, Disaster planning tips for older adults and their families, in: CDC Healthy Aging Program Health Benefits ABCs, 2013. https://www.cdc.gov/aging/pdf/disaster_planning_tips.pdf.
[42] S.R. Lowe, J.A. McGrath, M.N. Young, R.K. Kwok, L.S. Engel, S. Galea, D.P. Sandler, Cumulative disaster exposure and mental and physical health symptoms among a large sample of residents of the U.S. Gulf Coast residents, J. Trauma Stress 32 (2) (2019) 196–205, https://doi.org/10.1002/jts.22392.
[43] C. Ma, T.E. Smith, Increased alcohol use after Hurricane Ike: the roles of perceived social cohesion and social control, Soc. Sci. Med. 190 (2017) 29–37, https://doi.org/10.1016/j.socscimed.2017.08.014.
[44] A.N. Karanci, B. Aksit, G. Dirik, Impact of a community disaster awareness training program in Turkey: does it influence hazard-related cognitions and preparedness behaviors, SBP (Soc. Behav. Pers.): Int. J. 33 (3) (2005) 243–258, https://doi.org/10.2224/sbp.2005.33.3.243.
[45] J.D. Rivera, The likelihood of having a household emergency plan: understanding factors in the US context, Nat. Hazards 104 (2) (2020) 1331–1343, https://doi.org/10.1007/s11069-020-04217-z.
[46] Federal Emergency Management Agency, National household survey [data set], 2021. https://www.fema.gov/about/openfema/data-sets/national-household-survey, 2022.
[47] T. Gebrehiwot, A. van der Veen, Farmers prone to drought risk: why some farmers undertake farm-level risk-reduction measures while others not? Environ. Manag. 55 (3) (2015) 588–602, https://doi.org/10.1007/s00267-014-0415-7.
[48] P.A. Rippetoe, R.W. Rogers, Effects of components of protection-motivation theory on adaptive and maladaptive coping with a health threat, J. Personality Soc. Psychol. 52 (3) (1987) 596–604, https://doi.org/10.1037/0022-3514.52.3.596.
[49] P. Bubeck, W.J. Wouter Botzen, J. Laudan, J.C.J.H. Aerts, A.H. Thieken, Insights into flood-coping appraisals of protection motivation theory: empirical evidence from Germany and France, Risk Anal. 38 (6) (2017) 1239–1257, https://doi.org/10.1111/risa.12938.
[50] M. Scovell, C. McShane, A. Swinbourne, D. Smith, Rethinking risk perception and its importance for explaining natural hazard preparedness behavior, Risk Anal. 42 (3) (2022) 450–469, https://doi.org/10.1111/risa.13780.
[51] M.K. Lindell, R.W. Perry, Communicating Environmental Risk in Multiethnic Communities, SAGE Publications, 2003.
[52] M.K. Lindell, R.W. Perry, The protective action decision model: theoretical modifications and additional evidence, Risk Anal. 32 (4) (2012) 616–632, https://doi.org/10.1111/j.1539-6924.2011.01647.x.
[53] M.K. Lindell, Improving hazard map comprehension for protective action decision making, Front. Comput. Sci. 2 (2020), https://doi.org/10.3389/fcomp.2020.00027.
[54] L.B. Bourque, R. Regan, M.M. Kelley, M.M. Wood, M. Kano, D.S. Mileti, An examination of the effect of perceived risk on preparedness behavior, Environ. Behav. 45 (5) (2013) 615–649.
[55] Z. Zhou, J. Liu, H. Zeng, T. Zhang, X. Chen, How does soil pollution risk perception affect farmers' pro-environmental behavior? The role of income level, J. Environ. Manag. 270 (2020) 110806, https://doi.org/10.1016/j.jenvman.2020.110806.
[56] A. Ardalan, M. Mazaheri, M. Vanrooyen, H. Mowafi, S. Nedjat, K.H. Naieni, M. Russel, Post-disaster quality of life among older survivors five years after the Bam earthquake: implications for recovery policy, Ageing Soc. 31 (2) (2011) 179–196, https://doi.org/10.1017/S0144686X10000772.
[57] R.H. Pietrzak, P.H. Van Ness, T.R. Fried, S. Galea, F.H. Norris, Trajectories of posttraumatic stress symptomatology in older persons affected by a large-magnitude disaster, J. Psychiatr. Res. 47 (4) (2013) 520–526, https://doi.org/10.1016/j.jpsychires.2012.12.005.
[58] M.H. Lindberg, G. Chen, J.A. Olsen, B. Abelsen, Combining education and income into a socioeconomic position score for use in studies of health inequalities, BMC Publ. Health 22 (1) (2022) 969, https://doi.org/10.1186/s12889-022-13366-8.

[59] R. Muttarak, W. Pothisiri, The role of education on disaster preparedness: case study of 2012 Indian Ocean Earthquakes on Thailand's Andaman Coast, Ecol. Soc. 18 (4) (2013). https://www.jstor.org/stable/26269420.
[60] R. Williams, Generalized ordered logit/partial proportional odds models for ordinal dependent variables, STATA J. 6 (1) (2006) 58–82, https://doi.org/10.1177/1536867X0600600104.
[61] P.D. Allison, Missing Data, SAGE Publications, Inc, 2001.
[62] T.M. Al-rousan, L.M. Rubenstein, R.B. Wallace, Preparedness for natural disasters among older US adults: a nationwide survey, Am. J. Publ. Health 105 (S4) (2015) S621–S626, https://doi.org/10.2105/AJPH.2013.301559r.
[63] Mayors for a Guaranteed Income, Mayors for a guaranteed income, https://www.mayorsforagi.org, 2021. (Accessed 1 May 2023).
[64] Federal Emergency Management Agency, Community emergency response Team (CERT), https://www.fema.gov/emergency-managers/individuals-communities/preparedness-activities-webinars/community-emergency-response-team, 2022. (Accessed 19 December 2022).
[65] C.G. Flint, J. Stevenson, Building community disaster preparedness with volunteers: community emergency response teams in Illinois, Nat. Hazards Rev. 11 (3) (2010) 118–124.