Climate change anxiety, hurricane exposure, and climate change actions and attitudes: results from a representative, probability-based survey of US Gulf Coast residents

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Summary

Background Exposure to climate change-related threats (eg, hurricanes) has been associated with mental health symptoms, including post-traumatic stress symptoms. Yet it is unclear whether climate change anxiety, which is understudied in representative samples, is a specific mental health threat, action motivator, or both, particularly in populations exposed to climate-change related disasters. We sought to examine the associations between exposure to hurricanes, climate change anxiety, and climate change actions and attitudes in a representative sample of US Gulf Coast residents.

Methods This study used data from a 5-year, representative, prospectively assessed, probability-based, longitudinal cohort sample of residents in Texas and Florida (USA) exposed to exogenous catastrophic hurricanes rated category 3 or greater. Participants were adults aged 18 years and older and were initially recruited from the Ipsos KnowledgePanel in the 60 h before Hurricane Irma (Sept 8–11, 2017). Relationships between climate change anxiety, hurricane exposure, hurricane-related post-traumatic stress symptoms, general functional impairment, and climate change-related individual-level actions (eg, eating a plant-based diet and driving more fuel efficient cars) and collective-level actions (eg, petition signing and donating money) and climate change action attitudes were evaluated using structural equation modelling.

Findings The final survey was completed by 1479 individuals (787 [53·2%] women and 692 [46·8%] men). Two climate change anxiety subscales (cognitive-emotional impairment and perceived experience of climate change) were confirmed using confirmatory factor analysis. Mean values were low for both climate change anxiety subscales: cognitive-emotional impairment (mean 1·31 [SD 0·63], range 1–5) and perceived climate change experience (mean 1·67 [SD 0·89], range 1–5); these subscales differentially predicted outcomes. The cognitive-emotional impairment subscale did not significantly correlate with actions or attitudes; its relationship with general functional impairment was attenuated by co-occurring hurricane-related post-traumatic stress symptoms, which were highly correlated with general functional impairment in all three models (all p<0·0001). The perceived climate change experience subscale correlated with climate change attitudes (b=0·57, 95% CI 0·47–0·66; p<0·0001), individual-level actions (b=0·34, 0·21–0·47; p<0·0001), and collective-level actions (b=0·22, 0·10–0·33; p=0·0002), but was not significantly associated with general functional impairment in any of the final models. Hurricane exposure correlated with climate change-related individual-level (b=0·26, 0·10–0·42; p=0·0011) and collective-level (b=0·41, 0·26–0·56; p<0·0001) actions.

Interpretation Expanded treatment for post-traumatic stress symptoms after disasters could help address climate change-related psychological distress; experiences with climate change and natural hazards could be inflection points to motivate action.

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Introduction

The effects of climate change have arrived more swiftly and severely than initially predicted,[1] evident through escalating natural hazards and associated disasters exacerbated by a changing climate. Although many people globally agree that climate change will result in individual-level harm,[2] widespread action at the individual, collective, and policy levels has been limited. Climate change anxiety might motivate essential action to reduce impacts,[3] yet climate change anxiety and mental health symptoms associated with climate change-related disaster exposure could also compound the current global mental health crisis, where the need for care exceeds resources.[4]

Exposure to climate change-exacerbated extreme weather (eg, heatwaves, wildfires, and hurricanes)[5] and related hazards (eg, flooding) can become disasters when they intersect with human populations. Exposures are associated with mental health symptoms,[4,5] although estimates of mental health problems after such disasters vary considerably.[6] Many survivors show striking resilience, with normative short-term symptoms that

Research in context

Evidence before this study

Media reports and growing empirical research caution that climate change anxiety could threaten global mental health, particularly as climate change-related disasters become more common. Yet some anxiety might motivate protective behaviours, potentially facilitating increased performance of crucial climate change actions at the individual and collective level. We searched PubMed and Google Scholar for relevant articles published in English between March 1, 2022, and Oct 1, 2023, primarily using the terms "climate anxiety", "climate change anxiety", "eco-anxiety", and "environmental behaviors", "environmental actions", "climate change actions", and "pro-environmental attitudes". We found that emerging research has sought to define climate change anxiety and examine if it signals a mental health ailment or helps encourage climate change-related actions and attitudes. Yet no research to our knowledge has contrasted these possibilities in a representative, probability-based sample of residents repeatedly exposed to climate change-related hazards.

Added value of this study

Using a prospective, probability-based sample of US Gulf Coast residents who were repeatedly exposed to catastrophic hurricanes (hurricanes Harvey, Irma, and Michael), we confirmed two components of climate change anxiety (cognitive-emotional impairment and perceived climate change experience) as distinct subscales. Both subscales were low in the populace and differentially predicted outcomes. The cognitive-emotional impairment subscale did not correlate with actions or attitudes; its relationship with general functional impairment (impairment in social and occupational functioning) was attenuated by co-occurring hurricane-related post-traumatic stress symptoms. Higher perceived climate change experience correlated with more climate change-related actions and attitudes but not general functional impairment. More hurricane exposure correlated with reporting more climate change-related actions.

Implications of all the available evidence

Climate change anxiety's shared variability with hurricane-related post-traumatic stress symptoms suggests that expanded treatment for post-traumatic stress symptoms after disasters could help address psychological distress; experiences with climate change and related hazards could be inflection points to help motivate action.

improve over time.[7] Yet, harmful effects might be most pronounced among low-income and minoritised populations already disproportionately exposed to pollutants, disease burden, and other community-level stressors (ie, unemployment and low access to quality health care),[8] highlighting the environmental justice aspect of climate change exposures.

Key features of recent US Gulf Coast hurricanes, likely to have been exacerbated by climate change,[9] might have made them particularly psychologically distressing. Hurricane Harvey (2017) was strong and slow, and produced record rainfall and urban flooding;[9] Hurricane Irma (2017) was stronger, longer, and more persistent than typical, making landfall with Florida (USA) multiple times and inhibiting a safe evacuation route for those in harm's way.[10] Floridians exposed to hurricanes Irma (2017) and Michael (2018) reported post-traumatic stress symptoms that were associated with greater number of storm exposures (eg, lost property and evacuation zone residence).[11] Cumulative effects sensitised people to respond to future catastrophic storms with more mental health symptoms.[11]

One manifestation of mental health problems related to climate change-exacerbated extreme hazard exposure could be climate change anxiety. Climate change anxiety[12] and eco-anxiety (ie, anxiety related to environmental threats, particularly climate change)[3,13] have emerged as constructs of interest to help conceptualise psychological distress associated with climate change impacts. Climate change anxiety might stem from climate change-associated loss of physical community places, activities, or cultural traditions,[3] and might be related to one's direct experience of climate change or one's perception or concern about the problem.[14] Climate change anxiety has been conceptualised along several dimensions, including cognitive-emotional impairment and perceived experience of climate change.[12] Correlations between climate change anxiety and general functional impairment (ie, difficulty in social or occupational functioning[15]) could indicate climate change anxiety-related mental health difficulties requiring intervention. Yet research linking climate change anxiety to general functional impairment is nascent and mostly conducted on convenience samples and younger individuals.[12] Thus, although metrics of climate change anxiety have begun to elucidate its potential threat to mental health, climate change anxiety might also be a normative response to the existential threat of climate change, rather than a mental health problem requiring intervention. More research exploring the construct of climate change anxiety and its relationship with general functional impairment is needed to clarify associations. Moreover, although a study of a sample of 197 survey respondents showed generally low levels of climate change anxiety, correlations between climate change anxiety and depression and general anxiety were observed.[12] These findings suggest potential concurrent validity or overlap between climate change anxiety and other measures of psychological distress, or the possibility that climate change anxiety exacerbates existing mental health problems.

Concurrently, climate change anxiety and exposure to climate change-related disasters might trigger individual-level and collective-level climate change actions (including mitigation [eg, energy efficiency] and adaptation [eg, household preparation]) essential to reducing greenhouses gases and thwarting the worst effects of climate change.[16] Individual-level actions include lifestyle choices (eg, reducing meat consumption, saving energy in households, and driving electric cars) to directly reduce greenhouse gas emissions.[17] Collective-level actions seek systemic changes targeting actions or behaviours of others,[16] such as signing petitions or donating money to environmental groups[18] and community-level adaptation. Yet climate change actions can be costly in terms of time, finances, and access,[19] inhibiting the ability of those facing resource constraints to engage in climate change actions, even if the threat from climate change-related disasters is recognised and action is desired.[19] Moreover, although individual-level actions can lead to larger scale collective change when widely practised, previous research suggests little spillover between behaviours at the individual and collective level,[16] suggesting they might operate independently.

Because anxiety is an instinctual and cognitive threat response that might motivate climate change actions, some climate change anxiety might be adaptive,[3] signalling a stress response to an existential threat. For example, in a sample of young adults (aged 18–35 years), although climate change anxiety correlated with symptoms of generalised anxiety disorder and major depressive disorder, engaging in collective action attenuated the association between cognitive emotional impairment and depressive symptoms,[18] suggesting such actions might facilitate adaptive coping. Anxiety might also correlate with climate change action attitudes, in turn predicting future actions.[20] Conversely, some evidence suggests that elevated anxiety could threaten mental health and create avoidance or behavioural disengagement, lowering constructive climate change action.[3] Furthermore, because attitudes can precede or operate reciprocally with action,[21] they are also important correlates to consider.

Residents of the US Gulf Coast are vulnerable to climate change impacts given their frequent direct exposure to climate change-related threats. We aimed to explore relationships between acute, climate change-related hazard exposure, climate change anxiety, climate change actions (individual and collective) and attitudes, and general functional impairment among residents in Texas (USA) and Florida, controlling for hurricane-related post-traumatic stress symptoms. Because climate change anxiety is a developing construct, we implemented a structural equation modelling framework. This facilitates an exploration of the factor structure of climate change anxiety while testing the hypothesised model,[22] which proposes that hurricane exposure is associated with higher climate change anxiety, which in turn might be associated with climate change actions and attitudes, and general functional impairment (figure 1).

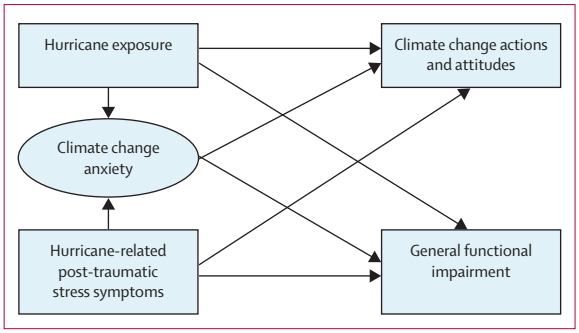

Figure 1: **Conceptual model of hurricane exposure, climate change anxiety, general functional impairment, and climate change actions and attitudes**

Methods

Study design and participants

We used data collected from a 5-year, representative, prospectively assessed, probability-based, longitudinal cohort sample of residents in Texas and Florida exposed to several exogenous catastrophic hurricanes rated category 3 or greater (ie, hurricanes Harvey, Irma, and Michael).

Participants were drawn from the Ipsos KnowledgePanel, which uses address-based sampling to randomly recruit panellists using probability-based sampling methods, designed to be representative of the USA. Address-based sampling uses the delivery sequence file of the US Postal Services, improving population coverage relative to traditional random-digit-dialling methods, and enabling recruitment of harder-to-reach individuals (eg, younger people or racial and ethnic minoritised groups). Participating households without internet connection are provided a web-enabled device and free internet services. Once household members are recruited for the panel and assigned to a study sample, they are notified electronically of the opportunity and can take surveys through their email link or online member page.

Between 1800 h on Sept 8, 2017, and 0600 h on Sept 11, 2017 (immediately preceding Hurricane Irma's landfall in Florida and several weeks after Hurricane Harvey's landfall in Texas) we invited all eligible KnowledgePanel panellists aged 18 years and older living in Florida or Texas for participation in wave 1 of our survey study. Wave 2 data were collected 4 weeks later (Oct 12–29, 2017). Wave 3 was administered 2–3 weeks after Hurricane Michael made landfall in Florida (Oct 22–Nov 6, 2018). Wave 4 was completed shortly before the 2020 hurricane season (May 14–27, 2020). Wave 5 data were collected after the 2021 hurricane season (Dec 22, 2021, to Jan 11, 2022). The first four waves focused primarily on exposure and response to catastrophic hurricanes more generally, the wave 5 survey focused more specifically on exposure and

response to climate change. Thus, unless indicated, wave 5 variables were used in the present analyses.

Participants provided informed consent when they joined the KnowledgePanel and were ensured confidentiality. The University of California, Irvine, and Stanford University Institutional Review Boards for Human Subjects research approved and reviewed all activities. STROBE guidelines[23] for cohort studies were followed. Initial analyses were preregistered on the Open Science Framework.

For the **Open Science Framework** see https://tinyurl.com/bdezcddk

Independent variables

For the measure of climate change anxiety, participants were asked "How often the following statements are true of you" (endpoints: 1=never to 5=almost always): (1) thinking about climate change makes it difficult for me to concentrate; (2) thinking about climate change makes it difficult for me to sleep; (3) I have nightmares about climate change; (4) I have been directly affected by climate change; (5) I have known someone who has been directly impacted by climate change; and (6) I have noticed a change in a place that is important to me due to climate change. Items were derived from two subscales, cognitive-emotional impairment (items 1–3, α=0·85) and perceived climate change experience (items 4–6, α=0·89), of a longer, validated measure of climate change anxiety.[12] The abbreviated measure was implemented to reduce participant burden and items were selected on the basis of a combination of factor loadings and face validity for the two subscales.[12] Confirmatory factor analysis verified climate change anxiety subscales using structural equation modelling.

To measure previous negative hurricane-related experiences, exposure to hurricane losses and injuries was evaluated at survey waves 1, 2, and 3 and responses were summed. Hurricane exposures (ie, home destroyed, lost property, injured, lost a pet, knew someone killed, or knew someone injured) were assessed at wave 1 (after Hurricane Harvey and before Hurricane Irma) and were re-evaluated at wave 2 (after Hurricane Irma) and wave 3 (after Hurricane Michael). The measure has been used in previous research.[11]

A modified version[11] of the Primary Care Post-traumatic Stress Disorder Screen for DSM-5[24] assessed hurricane-related post-traumatic stress symptoms. The modified version assesses symptoms with continuous, rather than dichotomous, response options.[11] Participants were asked to "Think about a prior hurricane you experienced that was most distressing to you (eg, Harvey, Michael, Irma, Rita). With respect to that hurricane, during the past week or so, how often have you experienced the following symptoms?" (including nightmares, avoidance, feeling on guard, feeling numb or detached, and feeling guilty or blaming yourself or others; endpoints: 1=never to 5=all the time). Reliability was very good (α=0·82).

See **Online** for appendix

Demographic indicators (age, income, education, race or ethnicity, and gender [male, female, or prefer to self-describe]) are collected by self-report by Ipsos and updated regularly.

Dependent variables

To measure individual-level climate change actions, a checklist assessed performance of the following activities in the past week and responses were summed: used public transportation, cycled, or walked to work instead of driving; used energy-efficient lightbulbs such as compact fluorescent lamps or light-emitting diodes; recycled; took shorter showers; drove a hybrid or electric vehicle; reduced red meat consumption; ate a more plant-based diet; reduced food waste; composted waste; checked the air in your tires to ensure fuel efficiency; used a smart thermostat; and installed or used low-flow shower heads or faucets. Items were based on previous research.[25]

Collective-level climate change actions were measured using a checklist that assessed performance of the following behaviours in the past year: worked with community members to help people prepare for hurricanes or other natural disasters; worked with community members to create green spaces (eg, plant trees or restore habitat) in my community; signed a petition in support of action to help the environment; signed a petition in support of action on climate change; and made a donation in support of action on climate change. The items were based on previous research[26] and responses were summed.

To measure climate change action attitudes, participants reported agreement with four statements (endpoints: 1=strongly disagree to 5=strongly agree): "I support the USA taking action to regulate carbon dioxide emissions"; "I support my community taking action to adapt to climate change (eg, building sea walls and requiring newly built homes to withstand storms)"; "I am willing to make sacrifices (eg, pay higher gasoline prices and reduce eating meat) to help stop climate change"; and "the costs of making personal changes to help stop climate change are too high". Items were derived from previous research.[27,28] Reliability was very good (α=0·85). Confirmatory factor analysis evaluated these attitudes as a latent construct using a structural equation modelling framework.

Four items from the Medical Outcomes Study 36-Item Short-Form Health Survey assessed occupational and social impairment (ie, general functional impairment) resulting from physical and mental health.[15] Participants responded (endpoints: 0=none of the time to 4=all of the time) to items including "During the past week, how much of the time has your emotional health interfered with your social relationships (like connecting with friends, relatives, etc)?" A mean was taken of the responses. Reliability was very good (α=0·86).

Additional details on dependent variables are in the appendix (p 2).

Statistical analysis

All data were weighted to account for probability of selection into the KnowledgePanel, attrition over time, and to adjust for differences between our sample and US Census benchmarks for Florida and Texas. The weighting procedure occurred using a multistage process. First, a design weight was calculated for all active members of the KnowledgePanel on the basis of current geodemographic benchmarks from the US Census Bureau's Current Population Survey. Then, these design weights were adjusted along with the base weights of the assigned sample (ie, qualified respondents from Texas and Florida). At wave 5, weighting benchmarks were based on the US Census Bureau's American Community Survey (2015–19), accounted for participants ageing since the wave 1 survey in 2017, and were calculated using the following demographic cells: gender (male or female), age (22–29, 30–44, 45–59, or ≥60 years), race or ethnicity (White and non-Hispanic, Black and non-Hispanic, other race and non-Hispanic, Hispanic, or two or more races and non-Hispanic); household income (less than US$25 000, $25 000–49 999, $50 000–74 999, $75 000–99 999, $100 000–149 999, and ≥$150 000); metropolitan and non-metropolitan areas, and education (less than high school or high school, some college, and Bachelor's degree or higher). Weights were trimmed at upper and lower bounds to avoid extreme weights and avoid sampling variability: Florida lower bound 1·71% and upper bound 98·40%; and Texas lower bound 2·49% and upper bound 97·51%. Further details are in the appendix (p 3).

Three structural equation models were constructed to evaluate the relationship between climate change anxiety, hurricane exposure, hurricane-related post-traumatic stress symptoms, general functional impairment, and each of the following: (1) individual-level climate change actions; (2) collective-level climate change actions; and (3) climate change action attitudes (figure 1). First, measurement models for climate change anxiety and climate change action attitudes were constructed. Climate change anxiety was evaluated as a single latent construct and as two distinct latent constructs according to its subscales: cognitive-emotional impairment and perceived climate change experience. Determination of measurement model fit was guided by theory and modification indices using a sequential approach to test for factorial invariance[29] (including correlating error terms and testing climate change anxiety subscales separately) until all indices were less than 3·84 (standard guideline).[30] Fit statistics were evaluated using the standardised root mean square residual and coefficient of determination. Standardised root mean square residual values close to 0 indicate a good model fit and coefficient of determination can be interpreted as percent variability explained by a model, analogous to R^2.

Then, for each structural model component, covariates were tested for statistical significance using a hierarchical variable entry strategy with individual-level demographic covariates added first and hurricane exposure added second. For parsimony, only covariates significant at $p<0·05$ were retained in subsequent models. Hurricane-related post-traumatic stress was included in each final structural model as a control variable since catastrophic hurricane exposure tends to be strongly associated with post-traumatic stress responses.[11] Structural model fit was evaluated using the standardised root mean square residual, coefficient of determination, and theory rather than a data driven approach that could lead to overfitting of the data.[31] Results are shown as standardised estimates and robust standard errors, as appropriate for complex survey data. Data were derived from an ongoing project. At α=0·05, a power of b=0·80, and up to 30 predictor variables estimated for a multiple linear regression, at n=1479, the study was well powered to detect small effects, with f^2=0·019.

Several post-hoc analyses were conducted. First, we added a path from previous hurricane exposure to post-traumatic stress symptoms. To test for potential measurement overlap between climate change anxiety and post-traumatic stress symptoms, we re-ran all analyses omitting the question, "I have nightmares about climate change".

Analyses were conducted using Stata version 18.

Role of the funding source

The funders of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Results

5940 eligible KnowledgePanel panellists living in Florida or Texas were invited for participation in wave 1, 2774 (46·7%) of whom completed the survey within the allotted timeframe for Florida (60 h from survey launch) or, for Texas residents, until we reached our target sample size of around 1000 Texans (15 h from survey launch). 2564 (86·6%) of 2960 individuals (which included some participants in a related study who did not take wave 1) completed the wave 2 survey. 1879 (70·2%) of 2677 individuals responded to the wave 3 survey. The wave 4 survey was completed by 1846 (73·6%) of 2507 individuals and the wave 5 survey was completed by 1479 (83·7%) of 1766 individuals.

The final sample of 1479 individuals available to be included in the analyses included 787 (53·2%) female participants and 692 (46·8%) male participants. Mean age was 51·5 years (SD 16·3). 814 (55·0%) participants were White, 178 (12·1%) were Black, 79 (5·3%) were other or mixed race and non-Hispanic, and 408 (27·6%) were Hispanic. 86 (5·8%) participants obtained less than a high school education, 483 (32·6%) reported a high school diploma, 456 (30·8%) reported some college education, and 454 (30·7%) reported a Bachelor's

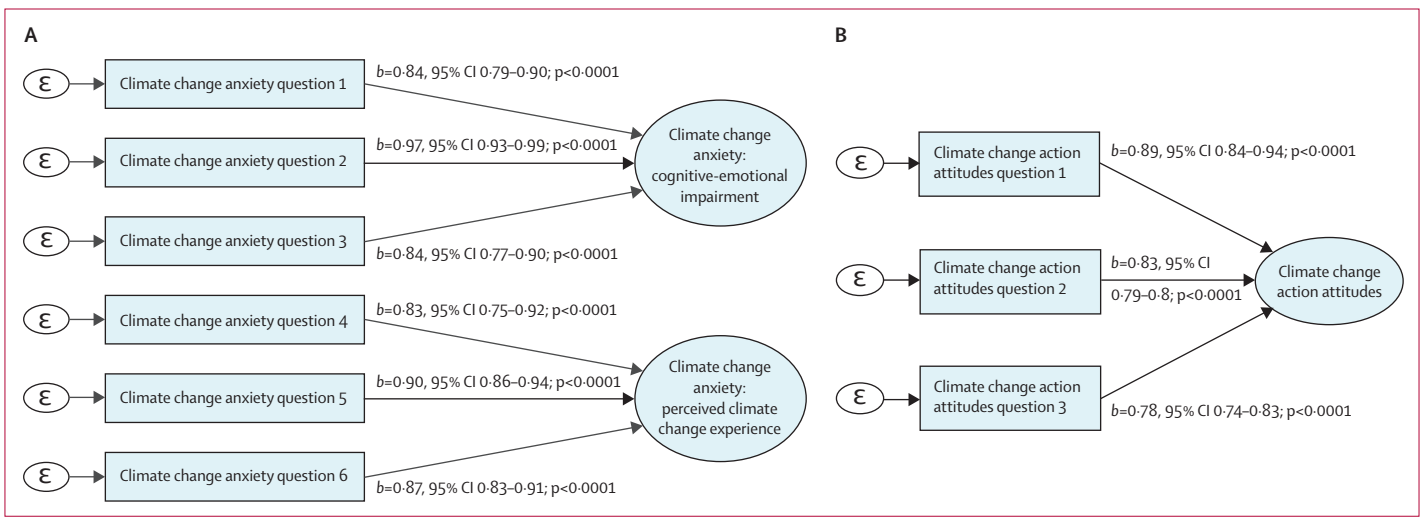

***Figure 2*: Measurement models for climate change anxiety and climate change action attitudes**
(A) Climate change anxiety measurement model for cognitive-emotional impairment (n=1462) and perceived climate change experience (n=1460). (B) Climate change action attitudes measurement model (n=1456). *b*=standardised coefficient. ε=error.

degree or higher. 422 (28·5%) participants had experienced one or more previous hurricane exposures (ie, losses or injury; mean 0·58 [SD 1·33], range 0–11). General functional impairment (mean 0·50 [SD 0·77], range 0–4) and hurricane-related post-traumatic stress symptoms (mean 1·26 [SD 0·53], range 1–5) were low. As reported elsewhere,[32] many people participated in at least some individual-level climate change actions (mean 3·33 [SD 2·30], range 0–12); 1350 (91·3%) performed at least one individual-level climate change action (eg, used public transportation or ate a more plant-based diet). Participation in collective-level climate change actions was lower than participation in individual-level climate change actions (mean 0·28 [SD 0·77], range 0–5) and 1229 (83·1%) participants reported no collective-level climate change actions.

Final weighted confirmatory factor analysis measurement models for the two climate change anxiety subscales (cognitive-emotional impairment and perceived climate change experience) are shown in figure 2A and appendix p 5. All factor loadings for each construct were more than 0·83 and modification indices were less than 3·84. Fit statistics were excellent for both climate change anxiety subscales: cognitive-emotional impairment (standardised root mean square residual <0·001 and coefficient of determination 0·951) and perceived experience of climate change (standardised root mean square residual <0·001 and coefficient of determination 0·906). Climate change anxiety was also evaluated as a single latent construct (see appendix p 7); for which factor loadings were much lower (coefficients for three items were <0·63), with modification indices that could lead to overfitting of the data through data driven, rather than theoretically derived, covariances (see appendix p 8). Thus, climate change anxiety was retained as two latent constructs (cognitive-emotional impairment and perceived climate change experience) in subsequent models and the correlation between these items was accounted for by specifying a covariance. On average, the participants reported low levels of both climate anxiety subscales: cognitive-emotional impairment (mean 1·31 [SD 0·63], range 1–5) and perceived climate change experience (mean 1·67 [SD 0·89], range 1–5).

Climate change action attitudes were also evaluated using confirmatory factor analysis (figure 2B and appendix p 9). The item "The cost of making personal changes to stop climate change" (reverse coded) loaded at standardised coefficient (*b*)=0·33 (95% CI 0·21–0·46) and was not included in subsequent analyses (see appendix p 10 for four-item measurement model). A three-factor model was retained, with excellent model fit statistics (standardised root mean square residual <0·001, coefficient of determination 0·887) and all modification indices less than 3·84. Because items comprising latent constructs were positively skewed, given the small amount of missing data, maximum likelihood estimates were used.[30]

Preliminary structural equation models showing relationships between covariates and key variables are shown in the table. Compared with identifying as White, identifying as Hispanic was associated with higher cognitive-emotional impairment, perceived climate change experience, and climate change action attitudes (table). Compared with White respondents, respondents identifying as other or mixed race or Black reported higher climate change action attitudes (table). Older age was associated with lower cognitive-emotional impairment, lower perceived climate change experience, engagement in more individual-level

	Climate change anxiety: cognitive-emotional impairment (n=1459)		Climate change anxiety: perceived climate change experience (n=1457)		Climate change action attitudes (n=1453)		Individual-level climate change actions (n=1458)		Community-level climate change actions (n=1460)		General functional impairment (n=1476)	
	b (95% CI)	p value	*b* (95% CI)	p value	*b* (95% CI)	p value	*b* (95% CI)	p value	*b* (95% CI)	p value	*b* (95% CI)	p value
Race and ethnicity*												
Hispanic	0·17 (0·07 to 0·27)	0·0006	0·16 (0·06 to 0·26)	0·0015	0·19 (0·09 to 0·29)	0·0002	0·03 (–0·06 to 0·12)	0·57	0·06 (–0·02 to 0·14)	0·14	0·02 (–0·08 to 0·12)	0·73
Non-Hispanic, or mixed or other race	0·01 (–0·06 to 0·08)	0·79	0·05 (–0·04 to 0·13)	0·30	0·08 (0·003 to 0·15)	0·040	0·02 (–0·09 to 0·12)	0·75	–0·04 (–0·09 to 0·01)	0·12	0·02 (–0·04 to 0·08)	0·51
Black	0·00 (–0·11 to 0·11)	1·0	0·07 (–0·02 to 0·16)	0·13	0·10 (0·002 to 0·20)	0·046	0·00 (–0·09 to 0·08)	0·97	–0·02 (–0·08 to 0·03)	0·44	–0·02 (–0·12 to 0·08)	0·69
Female gender†	0·06 (–0·04 to 0·16)	0·22	0·04 (–0·06 to 0·13)	0·41	0·11 (0·02 to 0·19)	0·014	0·10 (0·02 to 0·17)	0·012	0·08 (0·02 to 0·15)	0·011	–0·14 (–0·23 to –0·04)	0·0052
Age	–0·14 (–0·21 to –0·06)	0·0007	–0·11 (–0·18 to –0·03)	0·0062	–0·04 (–0·13 to 0·06)	0·46	0·16 (0·07 to 0·24)	0·0003	–0·02 (–0·09 to 0·04)	0·48	0·11 (0·02 to 0·20)	0·020
Bachelor's degree or higher‡	–0·01 (–0·11 to 0·09)	0·87	0·11 (0·02 to 0·21)	0·023	0·19 (0·11 to 0·27)	<0·0001	0·06 (–0·02 to 0·14)	0·13	0·12 (0·04 to 0·19)	0·0033	–0·05 (–0·13 to 0·03)	0·19
Income	0·02 (–0·13 to 0·18)	0·78	0·04 (–0·08 to 0·16)	0·49	0·04 (–0·06 to 0·13)	0·45	0·08 (–0·01 to 0·17)	0·072	0·01 (–0·06 to 0·07)	0·83	–0·13 (–0·26 to –0·001)	0·048
Previous hurricane exposure	0·27 (0·18 to 0·37)	<0·0001	0·25 (0·15 to 0·34)	<0·0001	0·00 (–0·07 to 0·08)	0·93	0·29 (0·15 to 0·43)	0·0001	0·48 (0·36 to 0·60)	<0·0001	0·23 (0·15 to 0·31)	<0·0001
Constant	..	..	..	..	..	..	0·48 (0·08 to 0·88)	0·017	0·03 (–0·31 to 0·36)	0·88	1·17 (0·60 to 1·74)	0·0001
Model fit	SRMR 0·017; CD 0·159	..	SRMR 0·014; CD 0·146	..	SRMR 0·016; CD 0·097	..	SRMR <0·001; CD 0·118	..	SRMR <0·001; CD 0·275	..	SRMR <0·001; CD 0·120	..

Denominators vary due to missing data. SMRS=standardised root mean square residual. *b*=standardised coefficient. CD=coefficient of determination. *White was the reference group. †Male gender was the reference group. ‡Less than a Bachelor's degree was the reference group.

Table: **Associations between potential covariates and key variables**

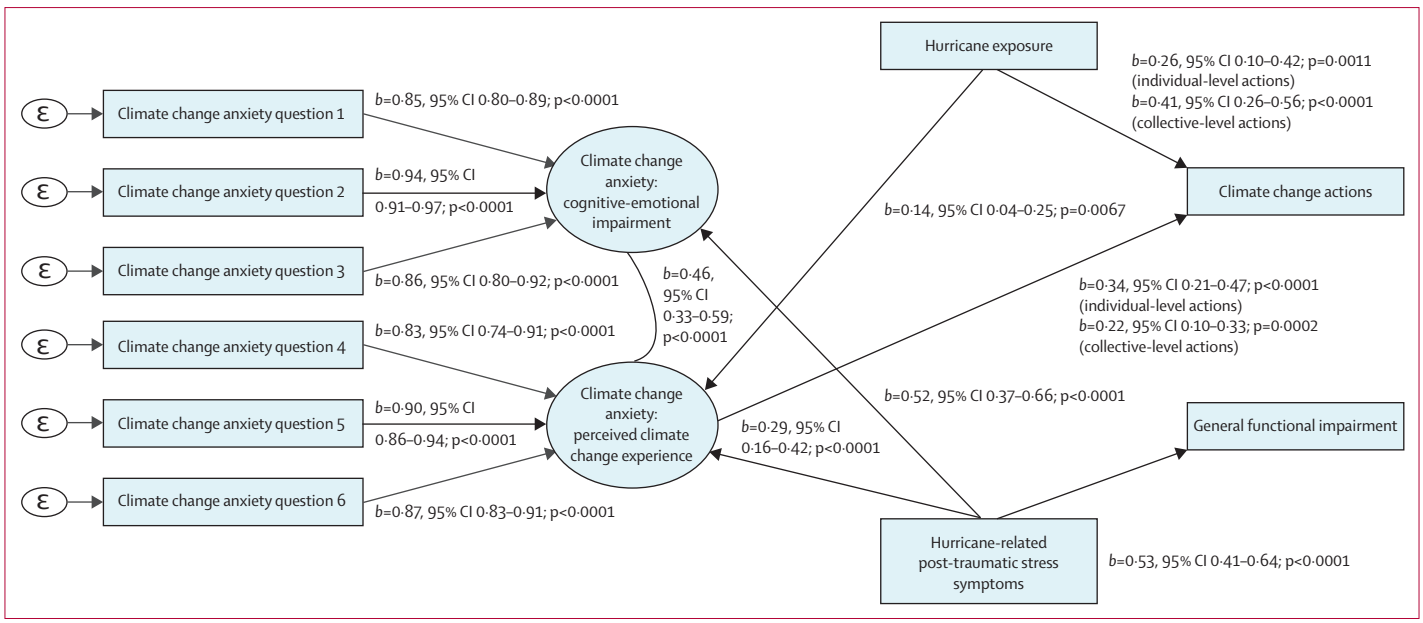

Figure 3: **Associations between climate anxiety and individual-level climate change actions (n=1431) and collective-level climate change actions (n=1434)**
Hurricane exposure was assessed at waves 1–3. Some estimates round differently between models due to missing data. For parsimony, unless indicated, estimates from the individual-level climate change action model are presented. *b*=standardised beta coefficient. ε=error.

climate change actions, and higher general functional impairment (table). Obtaining a Bachelor's degree or higher was associated with higher perceived climate change experience, climate change action attitudes, and engagement in community-level climate change actions (table). Higher income was correlated with lower general functional impairment (table).

Estimates from two analogous structural equation models for climate change anxiety, hurricane exposure, hurricane-related post-traumatic stress symptoms, general functional impairment, and individual-level and collective-level climate change actions are shown in figure 3 (full results are in the appendix pp 11–14). The figure shows only the statistically significant relationships between key variables. Some estimates round differently between models due to missing data. For parsimony, unless indicated, estimates from the individual-level climate change action model are presented. In the first structural equation model examining correlates of individual-level climate change actions, performing those behaviours was associated with higher perceived climate change experience (*b*=0·34, 95% CI 0·21–0·46; p<0·0001), more hurricane exposure over time (*b*=0·26, 0·10–0·42; p=0·0011), and female gender (*b*=0·09, 0·01–0·16; p=0·021). In the second, analogous structural equation model examining collective-level climate change actions, those actions were associated with higher perceived climate change experience (*b*=0·22, 0·10–0·33; p=0·0002), more hurricane exposure over time (*b*=0·41, 0·26–0·56; p<0·0001), and female gender (*b*=0·07, 0·01–0·14; p=0·028). In both models, hurricane-related post-traumatic stress symptoms correlated with more general functional impairment (*b*=0·53, 0·41–0·64; p<0·0001), cognitive-emotional impairment (*b*=0·52, 0·37–0·66; p<0·0001), and perceived climate change experience (*b*=0·29, 0·16–0·42; p<0·0001). Model fit statistics indicated excellent fit for individual-level (standardised root mean square residual 0·025 and coefficient of determination 0·613) and collective-level (standardised root mean square residual 0·025 and coefficient of determination 0·652) climate change action structural equation models.

The structural equation model of associations between climate change anxiety, hurricane exposure, hurricane-related post-traumatic stress symptoms, general functional impairment, and climate change action attitudes are shown in figure 4 and the appendix (pp 15–16). Climate change action attitudes were associated with higher perceived climate change experience (*b*=0·57, 95% CI 0·47 to 0·66; p<0·0001), obtaining a Bachelor's degree or higher (*b*=0·12, 0·05 to 0·19; p=0·0003), identifying as a Hispanic person compared with a White person (*b*=0·10, 0·004 to 0·19; p=0·041), and female gender (*b*=0·09, 0·02 to 0·17; p=0·018). Lower hurricane-related post-traumatic stress symptoms (*b*=–0·09, –0·18 to –0·001; p=0·047) correlated with higher climate change action attitudes.

In preliminary models controlling for all covariates except post-traumatic stress symptoms, cognitive-emotional impairment correlated with general functional impairment (individual-level and collective-level action model [*b*=0·36, 95% CI 0·20–0·52; p<0·0001]; climate change action attitudes model [*b*=0·34,

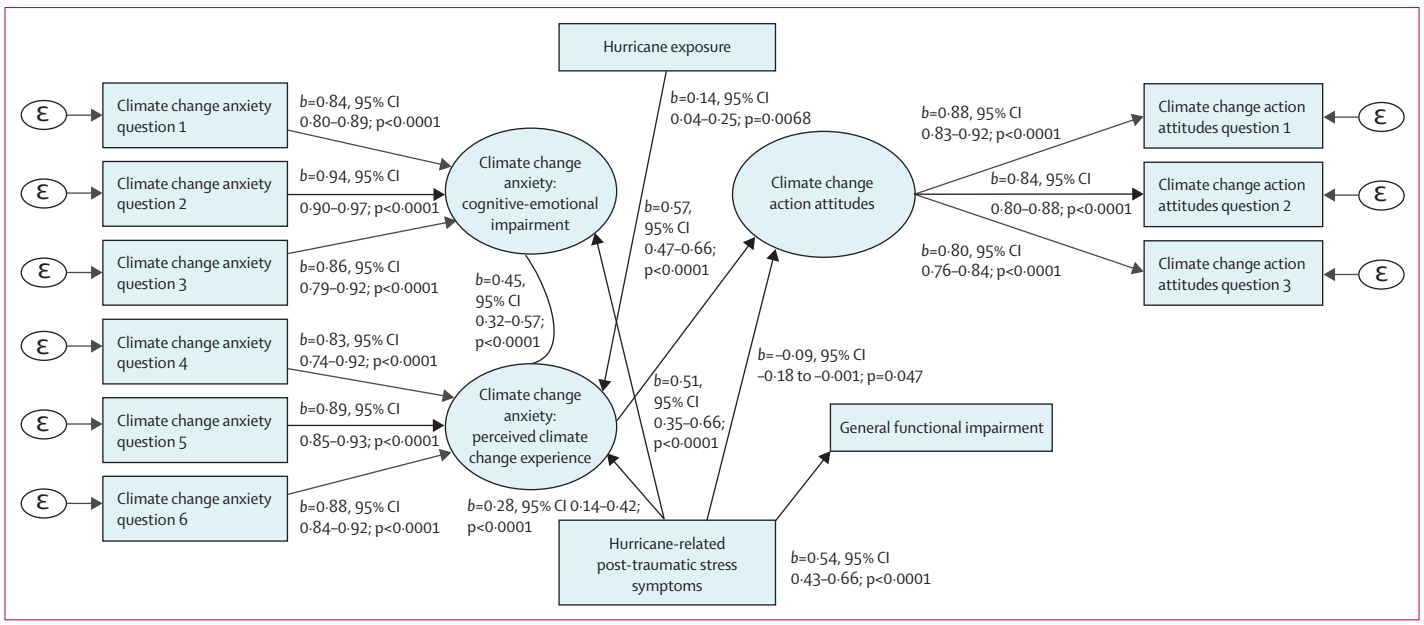

Figure 4: **Associations between climate anxiety and climate change action attitudes (n=1431)**
Hurricane exposure was assessed at waves 1–3. *b*=standardised beta coefficient. ε=error.

0·16–0·51; p=0·0001]). In all three final structural equation models, these relationships were no longer significant when hurricane-related post-traumatic stress symptoms were included in the models. These preliminary models are shown in the appendix (pp 17–22). Several post-hoc models were also tested. First, we added a path from previous hurricane exposure to post-traumatic stress symptoms. This association was significant (*b*=0·40, 0·30–0·50; p<0·0001). Specifying this relationship did not change the pattern of results and reduced model fit (possibly due to an overly complex model[33]). These models are shown in the appendix (pp 23–28). To evaluate if the high correlation between post-traumatic stress symptoms and the climate change anxiety cognitive-emotional impairment subscale was due to measurement overlap (eg, questions referring to nightmares about climate change and hurricanes), supplemental analyses re-analysed each structural equation model without the question, "I have nightmares about climate change." As the pattern of results was identical and the correlations were not substantially attenuated, all initial items were retained in the structural equation models and the original hypothesised models are shown here.

Discussion

Results from a representative sample of US Gulf Coast residents repeatedly exposed to acute climate extremes show that hurricane-related exposures and perceived experience of climate change were associated with performing more individual-level and collective-level climate change actions and reporting more climate change action attitudes. Contrastingly, the cognitive-emotional impairment subscale of climate change anxiety was associated with neither performing more climate change actions nor with climate change action attitudes. Hurricane-related post-traumatic stress symptoms, commonly studied in post-disaster contexts,[6] correlated with lower climate change action attitudes and attenuated the relationship between the cognitive-emotional impairment subscale and general functional impairment. This finding suggests addressing disaster-related mental health could be crucial to improving functioning and quality of life and bolstering psychological resources necessary to sustain attitudes that promote decisions to engage in positive climate change actions. Moreover, connecting personal experiences of climate change and acute climate change-related threats (eg, hurricanes) might more powerfully encourage climate change action attitudes and activities than capitalising on climate change anxiety as the primary motivator.

Our work aligns with results from a global survey from 24 countries that found personal experience with climate change correlated with greater intentions to act to mitigate the climate crisis.[34] We extend these findings by integrating an emerging psychological construct (ie, climate change anxiety) as a behavioural correlate. Similar to our findings, in a representative sample of Mexico residents, a population highly vulnerable to climate change-related threats, personal experience of extreme weather events correlated with more climate change actions (eg, saving water and electricity) beyond those types of actions pertinent to that specific threat (eg, preparing for a future flood or heatwave).[35] We replicate and extend these findings, showing that hurricane exposure was associated with climate change

actions beyond those related to hurricane preparation and mitigation and with climate change action attitudes more broadly.

Generally, our respondents reported low levels of climate change anxiety. An online convenience sample of UK residents also showed low climate change anxiety, despite high climate change concern, which was inconsistently associated with climate change actions.[36] We expand such research, showing components of climate change anxiety (ie, cognitive-emotional impairment compared with perceived experience) differentially correlated with climate change actions and attitudes in a representative sample repeatedly exposed to catastrophic hurricanes: perceived experience, not distress, correlated with climate change actions. Although previous research suggests that climate change anxiety is not uncommon in youth,[37] our results found relatively low climate change anxiety in a representative sample of adults. This finding aligns with recent research showing younger individuals tend to have higher emotional responses (eg, fear and anxiety) to climate change compared with older individuals.[38] This result might also be due to our sample being representative of the general population, rather than a clinical sample of distressed individuals, and thus more generalisable to the population overall.

Many Texas and Florida residents (including those living further from the coast) might be insulated from the most severe climate change impacts (eg, loss of life and total destruction of property) and some might attribute increased catastrophic hurricane occurrence to natural variability in weather patterns.[39] Indeed, the majority of our respondents had not experienced any hurricane-related losses or injuries. Thus, climate change anxiety might increase as impacts worsen or attributions shift.[39] For example, Inuit communities in northern Canada and family farmers in the Australian wheatbelt, with more direct connections to ecosystems and landscapes impacted by climate change, tend to report higher climate change anxiety.[40]

After accounting for hurricane-related post-traumatic stress symptoms, the cognitive-emotional impairment subscale of climate change anxiety was not uniquely associated with general functional impairment, one hallmark of poor mental health.[41] Yet climate change consequences (eg, disaster exposure) more broadly could threaten mental health through disaster-related post-traumatic stress symptoms, global distress, and associated general functional impairment.[11] Indeed, our findings align with those showing exposure to the direct impacts of climate change (such as hurricane exposure) correlates with more mental health problems and general functional impairment.[5] Thus, medical professionals (eg, psychotherapists and primary care service providers) should be aware of the psychological risks from exposure to climate change, particularly for individuals directly exposed to disasters. For people with subclinical symptoms, particularly minor or transient symptoms that do not require clinical intervention, social engagement that increases meaning, efficacy, and social connection could be helpful,[14] further motivating collective action to reduce climate change impacts. Such action might include toolkits, workshops, train-the-trainer approaches, web-based teaching, enhanced clinical assessments and support, and, when necessary, individual and group therapy.[42] Public health efforts should provide these opportunities in lower-resource priority populations to promote climate change actions and increase health equity.

Community-level approaches to addressing the mental health impacts of climate change and promoting climate change mitigation and adaption behaviour are needed, as individuals experience and respond to climate change and related threats in the context of their communities and ecosystems.[43] Yet community-based interventions are complex and often ineffective in their implementation,[44] highlighting an important area for future research. There is some evidence that efforts to build social capital and community resilience through improving social networks and social cohesion could protect mental health in post-disaster settings.[45] However, in practice, interventions aimed at improving social capital have produced limited evidence for long-term, sustainable efficacy at improving outcomes.[46] Behaviour-based interventions that leverage social norms and occur at key inflection points of change (eg, in the immediate aftermath of a climate change-related disaster)[44] should be promoted as potential areas of interest for future research. As supported by preliminary work on the salutary effects of environmental activism in youth,[18] such interventions could simultaneously improve mental health and encourage behaviours aimed at mitigating climate change impacts.

Although validation of the climate change anxiety scale was not a primary goal of this project, results from the confirmatory factor analysis suggest that although the current measure provides useful insights in a burgeoning field, rigorous investigations to bolster measure development might be of further use. The relationship between climate change anxiety and post-traumatic stress symptoms, for example, should be more clearly specified and delineated to minimise measurement error and guide future implementation. Similar to our findings, initial measure development of climate change anxiety also showed distinct factor loadings between the climate change anxiety subscales, suggesting perceived climate change experience was a correlate, rather than a component, of climate change anxiety.[12] However, other investigations of climate change anxiety have yielded results inconsistent with the initial measure development, resulting in conceptual and statistical critiques.[47] Given the importance of climate change anxiety for understanding psychological and

behavioural responses to climate change, recommendations include more rigorous investigations into how to measure climate change anxiety in a robust, consistent capacity, appropriate for diverse populations.[47] We suggest a combination of focus groups with diverse samples, cognitive interviews, and psychometric evaluations with representative samples.

Study strengths include a prospective design and use of a representative, probability-based sample of residents at risk for climate change-related threats. We acknowledge several limitations. Our primary independent and dependent variables were assessed cross-sectionally. Although our hypothesised model stated that climate change anxiety might be a motivator of climate change-related attitudes and actions, there are likely to be reciprocal effects (eg, having more climate change attitudes increases attention to climate change and thus climate change anxiety). We did not include risk perceptions or subjective attribution of extreme weather to climate change, which might correlate with worry and protective behaviours.[39] We did not conduct preliminary qualitative work with Gulf Coast residents before survey administration—the measures of climate change anxiety were not developed specifically for Gulf Coast residents and have not been developed nor validated on representative samples of adults. Future qualitative work would enhance quantitative findings. Neither climate change-related media exposure nor future orientation were assessed, but might correlate with psychological distress[11] and engagement in climate change actions.[48] A study of French youth found that both future orientation and information seeking were associated with climate change anxiety and climate change actions.[49] We assessed exposure to an acute threat (ie, catastrophic hurricanes), but chronic threats (eg, nuisance flooding) might show divergent associations.

Although income and education were not strong and consistent predictors of climate change actions, some actions might not be applicable or possible for all respondents, owing to financial or practical constraints (eg, expense or impracticality in multi-unit dwellings of hybrid cars, and donating money). Moreover, historically disadvantaged populations look at climate change and ways to mitigate it differently or more broadly. In a 2020 study, Song and colleagues found that minority racial and ethnic groups and groups with lower socioeconomic status were more likely to consider a broader range of issues such as racism or obesity as environmental issues.[50] Furthermore, the relationship between these key demographics and environmental perceptions are mediated by environmental justice perceptions—racism and obesity are environmental justice issues. Hence, action on a broader set of issues might be seen as acting on environmental problems or climate change, which might not currently be captured in existing measures of climate change action, potentially underestimating individual-level or collective-level action. This would be a fruitful area for future research.

Large-scale data on climate change actions and attitudes are essential to informing climate change policy and encouraging mitigation and adaption behaviour. Our findings suggest negative hurricane-related experiences and personal experience with climate change are both relevant for understanding climate change actions. The results suggest that intervention efforts should focus on connecting personal experiences with climate change with proactive solutions, while seeking to mitigate anxiety and related psychological problems such as disaster-related post-traumatic stress symptoms. Disaster-related psychiatric symptoms might hinder productive action; screen-and-treat approaches and other relevant psychological first aid strategies[51] should be implemented accordingly. As the climate change crisis escalates and its impacts intensify, future research should continue to monitor the effect on climate change anxiety, and improve guidelines on its measurement and treatment.

Contributors

DRG: conceptualisation, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, validation, data visualisation, and writing the original draft. GW-P: conceptualisation, funding acquisition, investigation, methodology, project administration, resources, and writing (review and editing). Both authors had full access to the data and accessed and verified the data. Both authors had responsibility for the integrity of the data and the accuracy of the data analysis. Both authors had final responsibility for the decision to submit for publication.

Declaration of interests

We declare no competing interests.

Data sharing

Data and analytic codes will be available on the Open Science Framework after publication and are available from the authors by request from the corresponding author (dgarfin@ucla.edu).

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References

1 Tollefson J. Climate change is hitting the planet faster than scientists originally thought. *Nature* 2022; published online Feb 28. https://doi.org/10.1038/d41586-022-00585-7.

2 Bell J, Poushter J, Fagan M, Huang C. In response to climate change, citizens in advanced economies are willing to alter how they live and work. 2021. https://pewrsr.ch/3EgOxo8 (accessed May 19, 2024).

3 Ojala M, Cunsolo A, Ogunbode CA, Middleton J. Anxiety, worry, and grief in a time of environmental and climate crisis: a narrative review. *Annu Rev Environ Resour* 2021; **46:** 35–58.

4 Lowe SR, Garfin DR. Crisis in the air: the mental health implications of the 2023 Canadian wildfires. *Lancet Planet Health* 2023; **7:** e732–33.

5 Obradovich N, Migliorini R, Paulus MP, Rahwan I. Empirical evidence of mental health risks posed by climate change. *Proc Natl Acad Sci USA* 2018; **115:** 10953–58.

6 Lowe SR, Bonumwezi JL, Valdespino-Hayden Z, Galea S. Posttraumatic stress and depression in the aftermath of environmental disasters: a review of quantitative studies published in 2018. *Curr Environ Health Rep* 2019; **6:** 344–60.

7 Garfin DR, Ramos D, Silver RC. Responses to natural disasters. In: Friedman HS, Markey CH, eds. Encyclopedia of mental health, 3rd edn. Oxford, UK: Elsevier, 2023: 44–57.

8 Arcaya MC, Tucker-Seeley RD, Kim R, Schnake-Mahl A, So M, Subramanian SV. Research on neighborhood effects on health in the United States: a systematic review of study characteristics. *Soc Sci Med* 2016; **168:** 16–29.

9 Trenberth KE, Cheng L, Jacobs P, Zhang Y, Fasullo J. Hurricane Harvey links to ocean heat content and climate change adaptation. *Earths Futur* 2018; **6:** 730–44.

10 Espinel Z, Kossin JP, Galea S, Richardson AS, Shultz JM. Forecast: increasing mental health consequences from Atlantic hurricanes throughout the 21st century. *Psychiatr Serv* 2019; **70:** 1165–67.

11 Garfin DR, Thompson RR, Holman EA, Wong-Parodi G, Silver RC. Association between repeated exposure to hurricanes and mental health in a representative sample of Florida residents. *JAMA Netw Open* 2022; **5:** e2217251.

12 Clayton S, Karazsia BT. Development and validation of a measure of climate change anxiety. *J Environ Psychol* 2020; **69:** 101434.

13 Hogg TL, Stanley SK, O'Brien LV, Wilson MS, Watsford CR. The Hogg Eco-Anxiety Scale: development and validation of a multidimensional scale. *Glob Environ Change* 2021; **71:** 102391.

14 Clayton S. Climate change and mental health. *Curr Environ Health Rep* 2021; **8:** 1–6.

15 Ware JE Jr, Sherbourne CD. The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. *Med Care* 1992; **30:** 473–83.

16 Lacroix K, Carman JP, Goldberg MH, Gustafson A, Rosenthal SA, Leiserowitz A. Does personal climate change mitigation behavior influence collective behavior? Experimental evidence of no spillover in the United States. *Energy Res Soc Sci* 2022; **94:** 102875.

17 Capstick S, Lorenzoni I, Corner A, Whitmarsh L. Prospects for radical emissions reduction through behavior and lifestyle change. *Carbon Manag* 2014; **5:** 429–45.

18 Schwartz SEO, Benoit L, Clayton S, Parnes MF, Swenson L, Lowe SR. Climate change anxiety and mental health: environmental activism as buffer. *Curr Psychol* 2022; 1–14.

19 Olumba CN, Ihemezie EJ, Olumba CC. Climate change perception, adaptation strategies, and constraints amongst urban farmers in Anambra Metropolis, Nigeria. *Clim Dev* 2023; published online June 25. https://doi.org/10.1080/17565529.2023.2221685.

20 Xiao C, Buhrmann J. Ideas to action: environmental beliefs, behaviors, and support for environmental policies. *J Environ Stud Sci* 2019; **9:** 196–205.

21 Weinstein ND. Testing four competing theories of health-protective behavior. *Health Psychol* 1993; **12:** 324–33.

22 Gunzler D, Chen T, Wu P, Zhang H. Introduction to mediation analysis with structural equation modeling. *Shanghai Jingshen Yixue* 2013; **25:** 390–94.

23 von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Lancet* 2007; **370:** 1453–57.

24 Bovin MJ, Kimerling R, Weathers FW, et al. Diagnostic accuracy and acceptability of the Primary Care Posttraumatic Stress Disorder Screen for the Diagnostic and Statistical Manual of Mental Disorders (Fifth Edition) among US veterans. *JAMA Netw Open* 2021; **4:** e2036733.

25 Mascatelli K, Drummond Otten C, Piacentini RV, Wong-Parodi G, States SL. Comparisons of sustainability behaviors pre- and early pandemic among botanical garden members. *Front Sustain Cities* 2021; **3:** 1–11.

26 Roser-Renouf C, Maibach EW, Leiserowitz A, Zhao X. The genesis of climate change activism: from key beliefs to political action. *Clim Change* 2014; **125:** 163–78.

27 van Valkengoed AM, Steg L, Perlaviciute G. Development and validation of a climate change perceptions scale. *J Environ Psychol* 2021; **76:** 101652.

28 Tern PC, Dietz T, Abel T, Guagnano GA, Kalof L. A value-belief-norm theory of support for social movements: the case of environmentalism. *Hum Ecol Rev* 1999; **6:** 81–97.

29 Yoon M, Kim ES. A comparison of sequential and nonsequential specification searches in testing factorial invariance. *Behav Res Methods* 2014; **46:** 1199–206.

30 STATA Corp. Stata SEM Intro 4. https://www.stata.com/manuals13/semintro4.pdf (accessed May 19, 2024).

31 Burnham KP, Anderson DR. Model selection and multimodel inference: a practical information-theoretic approach, 2nd edn. New York, NY: Springer-Verlag, 2002.

32 Garfin DR, Zernick MV, Wong-Parodi G. Emotions, worry, efficacy, and climate change-related sustainability behaviors among a representative sample of Texas and Florida residents. *Clim Change* 2024; **177:** 54.

33 West SG, Taylor AB. Model fit and model selection in structural equation modeling. In: Hoyle RD, ed. Handbook of structural equation modeling. New York, NY: The Guildford Press, 2012: 209–31.

34 Broomell SB, Budescu DV, Por H-H. Personal experience with climate change predicts intentions to act. *Glob Environ Change* 2015; **32:** 67–73.

35 López-Feldman A, González E. Extreme weather events and pro-environmental behavior: evidence from a climate change vulnerable country. *Appl Econ Lett* 2024; **31:** 465–69.

36 Whitmarsh L, Player L, Jiongco A, et al. Climate anxiety: what predicts it and how is it related to climate action? *J Environ Psychol* 2022; **83:** 101866.

37 Hickman C, Marks E, Pihkala P, et al. Climate anxiety in children and young people and their beliefs about government responses to climate change: a global survey. *Lancet Planet Health* 2021; **5:** e863–73.

38 Poortinga W, Demski C, Steentjes K. Generational differences in climate-related beliefs, risk perceptions and emotions in the UK. *Commun Earth Environ* 2023; **4:** 229.

39 Wong-Parodi G, Berlin Rubin N. Exploring how climate change subjective attribution, personal experience with extremes, concern, and subjective knowledge relate to pro-environmental attitudes and behavioral intentions in the United States. *J Environ Psychol* 2022; **79:** 101728.

40 Cunsolo A, Ellis NR. Ecological grief as a mental health response to climate change-related loss. *Nat Clim Chang* 2018; **8:** 275–81.

41 Edlund MJ, Wang J, Brown KG, et al. Which mental disorders are associated with the greatest impairment in functioning? *Soc Psychiatry Psychiatr Epidemiol* 2018; **53:** 1265–76.

42 Cunsolo A, Harper SL, Minor K, Hayes K, Williams KG, Howard C. Ecological grief and anxiety: the start of a healthy response to climate change? *Lancet Planet Health* 2020; **4:** e261–63.

43 Mah AYJ, Chapman DA, Markowitz EM, Lickel B. Coping with climate change: three insights for research, intervention, and communication to promote adaptive coping to climate change. *J Anxiety Disord* 2020; **75:** 102282.

44 Whitmarsh L, Poortinga W, Capstick S. Behaviour change to address climate change. *Curr Opin Psychol* 2021; **42:** 76–81.

45 Hall CE, Wehling H, Stansfield J, et al. Examining the role of community resilience and social capital on mental health in public health emergency and disaster response: a scoping review. *BMC Public Health* 2023; **23:** 2482.

46 Flores EC, Fuhr DC, Bayer AM, Lescano AG, Thorogood N, Simms V. Mental health impact of social capital interventions: a systematic review. *Soc Psychiatry Psychiatr Epidemiol* 2018; **53:** 107–19.

47 Wullenkord MC, Tröger J, Hamann KRS, Loy LS, Reese G. Anxiety and climate change: a validation of the Climate Anxiety Scale in a German-speaking quota sample and an investigation of psychological correlates. *Clim Change* 2021; **168:** 1–23.

48 Garfin DR, Thompson RR, Wong-Parodi G. Media exposure, threat processing, and mitigation behaviors in Gulf Coast residents facing the co-occurring threats of COVID-19 and hurricanes. *Risk Anal* 2022; **43:** 1370–86.

49 Nadarajah K, David JC, Brun L, et al. "We are running out of time": temporal orientation and information seeking as explanatory factors of climate anxiety among young people. *Psych* 2022; **4:** 560–73.

50 Song H, Lewis NA Jr, Ballew MT, et al. What counts as an "environmental" issue? Differences in issue conceptualization by race, ethnicity, and socioeconomic status. *J Environ Psychol* 2020; **68:** 101404.

51 Brewin CR, Scragg P, Robertson M, Thompson M, d'Ardenne P, Ehlers A. Promoting mental health following the London bombings: a screen and treat approach. *J Trauma Stress* 2008; **21:** 3–8.